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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI.

1913-1914.

W. J. HOLLAND, *Editor*

PITTSBURGH.
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PREFATORY NOTE.

The Sixth Volume of the Memoirs is composed of papers dealing exclusively with fossil and recent fishes. This is the result of mere chance. The various papers dealing with these animals happened to be ready for publication and were taken up and incorporated in the volume as they were presented by their authors.

From an ichthyological standpoint the amount of information contained in the pages of this book is very great, and the results of the researches embodied in its pages mark a decided advance in our knowledge of the subjects treated. No less than fifty-four species of recent fishes are described as new to science, and there are thirteen species of fossil fishes which are for the first time described. Several new genera have been erected by the authors who have contributed to the volume.

The authors represented in these memoirs are all recognized as leaders in their respective fields. It may be proper to call attention to the fact that the paper upon the fishes of Japan by Dr. David Starr Jordan, the prince of American ichthyologists, is stated by him to be his final contribution to his favorite science, to the study of which he has devoted forty years of his busy and successful life. Following the example of Linnæus he gives to the last species, for which he furnishes a name, the specific designation of *bona-nox*, "Good night!" (cf. p. 306). It is with sentiments of profound regret that his friends realize that Dr. Jordan feels the necessity for bringing his ichthyological researches to an end.

Trusting that this volume of the Memoirs may do much to promote the interesting science with which it deals, the Editor sends it forth with a certain feeling of satisfaction as he reviews the laborious hours which were spent by him in preparing its pages for publication. No matter how carefully an author may have prepared his manuscript, experience reveals that there are always in these days of typewriters errors inadvertently made in transcription, which call for correction. In the preparation of the publications of the Carnegie Museum the Editor for many years has made it his first duty to carefully read the manuscript, noting all minor errors whether in composition or punctuation, and designating the style of type to be used, thus preparing the manuscript for the printer. He has also supervised the preparation of the illustrations and the arrangement of the figures upon the

plates, in many cases with his own hands retouching photographs or correcting minor errors in drawing. After that, it has been his duty to read both the galley- and page-proofs as they have come to his hands, and finally to index the different volumes before having them bound up in permanent form. It is needless to say that this work has necessitated constant labor and unremitting attention to minute details. The Editor does not indulge in these observations at this point for the purpose of calling attention to the part which he has necessarily been compelled to take in this work, but for the purpose of expressing to the authors whose productions have passed through his hands the hope that they have not found occasion to quarrel with his activities. In the performance of his editorial duties the Editor has kept before himself as his constant aim the revelation of the exact thought of his friends, the authors, in the form of correct English. He has always striven to express the exact meaning intended to be conveyed by the writer, even when he has seen fit (as has frequently been the case) to radically modify the verbiage employed, to transpose words and paragraphs, or to eliminate unnecessary repetition.

W. J. Holland.

Carnegie Museum,
November 14, 1914.

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ERRATA AND CORRIGENDA

Page 16, second line from bottom, for "*Capocta*" read *Capoeta*.
Page 44, for "Tylesius" read Tilesius.
Page 55, for "*cheilidoniehthys*" read *Chelidonichthys*.
Page 56, for "*chlœa*" read *Chloea*.
Pages 101 and 102, for "*L. micropterus*" read *L. macropterus*.
Pages 109 and 132, for "*Steatogenes*" read *Steatogenys*.
Page 159, second line from top, for "*electrophorus*" read *electricus*.
Page 248, for "*Safole Tæniura*" read *Safole tæniura*.
Page 256 (no. 156), for "*Raius*" read *Taius*.
Page 287. For "*Ctebogobius*" read *Ctenogobius*.
Page 366, seventh line from bottom. For "*H. inimontis*" read *N. inimontis*.
Plate XXII. For "*Adenosternarchus*" read *Adontosternarchus*.
Plate XLII. For "*Sciænia*" read *Sciæna*.

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MEMOIRS

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CARNEGIE MUSEUM.

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W. J. HOLLAND, EDITOR.

A CATALOG OF THE FISHES KNOWN FROM THE WATERS OF KOREA.

BY DAVID STARR JORDAN AND CHARLES WILLIAM METZ

PITTSBURGH.

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. 1.

A CATALOG OF THE FISHES KNOWN FROM THE WATERS OF KOREA.

By David Starr Jordan and Charles William Metz.

(Plates I–X.)

In the summer of 1911 the senior author visited Korea, and with the aid of the authorities in charge of the fisheries made a considerable collection of the fishes of Korea (Chosen), especially of those obtainable at Fusan, and those seen in the markets at Seoul, the collection being in the interest of the Carnegie Museum of Pittsburgh, and of the Museum of Stanford University. Subsequently a still larger collection was brought together by Mr. B. Ihara, Commissioner of Fisheries for Chosen, and afterwards forwarded to the United States. This collection was made under the orders of General Terauchi, Governor General of Chosen, and of Mr. Yamagata, Vice-governor A considerable number of fishes from Suigen (Suwon) was obtained by Dr. K. Honda, Director of the Agricultural Experiment Station located at that place, which is inland, about fifty miles southward of Seoul.

The localities represented in our collections are the following: Fusan, the port at the southern extremity of Korea; Chemulpo, the port of Seoul; Suigen, (in Japanese *Suwon*), on an inland stream, tributary to the River Han, about fifty miles south of Seoul; Heijo, near Pyeng-yang in northwestern Korea; and

Chinnampo, the port of Pyeng-yang. We have also included the species taken by Mr. Pierre Louis Jouy and described by Jordan and Snyder from the large island of Tsushima, which lies between Fusan and Shimonoseki. This island belongs politically to Japan, but geographically rather to Korea.

The marine fauna of these regions is fairly well known, but the record of the river-fauna is still very far from complete.

The synonymy of several species is uncertain, and the identity of some with Chinese species on the one hand or with Japanese forms on the other is still far from certain. Numerous genera and species recorded from the Amur River by Dybowsky and by Berg have yet to be compared with Korean forms. The most valuable work so far done on the fish-fauna of this region is that of Dr. Peter Schmidt and his colleague in the Museum of St. Petersburg, Dr. Leo S. Berg.

The present paper gives a list of all the species known to occur in Korea, or in the seas immediately adjoining. It includes the species of the present collection, as well as those in the Museum of St. Petersburg, collected by Herz and by Schmidt, described later in different papers by Dr. Solomon Herzenstein, Dr. Peter Schmidt, and Dr. Leo S. Berg. There are also included the species obtained for the United States National Museum by Pierre Louis Jouy at Gensan and Fusan, and those obtained at Port Arthur by Professor Francis James Abbott, and sent to Stanford University. While Port Arthur is outside of Korea, its fauna must be identical with that of the near-by ports of Chinnampo and Chemulpo in Korea. The collections of Jouy and Abbott have been described by Jordan and Starks in the Proceedings of the United States National Museum. We have further included the marine fishes mentioned by Basilewsky, in his *Ichthyographia Chinæ Borealis* (1855) from the gulf of Pechili about Tientsin. The species named in this work are very imperfectly described and some of them can only, if at all, be recognized by their Chinese names. Some species noted by Basilewsky are here described in detail for the first time. We include these, as there is apparently no real difference between the marine fauna at Tientsin and that on the opposite side of the Gulf at Port Arthur, Chinnampo, and Chemulpo. There seems to be very little difference between the fishes of the west shore and those of Fusan at the southern extremity of Korea. All these bays, Fusan, Chemulpo, and Chinnampo, have sandy bottoms, and are much frequented by flounders, soles, conger-eels, croakers, gobies, and other fishes of the sands. The market of Fusan forms a rather striking contrast to that of Shimonoseki, the nearest town on the Japanese side of the Straits of

Tsushima. At Shimonoseki many species frequenting rocks are taken. The fauna of Gensan on the northeastern coast of Korea beyond Gensan is apparently northern, approaching that of Saghalin. The subarctic fauna described by Schmidt and others from Saghalin, Vladivostok, and Peter the Great Bay, undoubtedly extends along the Korean shores as far as Gensan. In the present list we have not included any of these species, unless actually recorded from Korea. These northern forms are not closely related to the fauna of the temperate zone found in the waters of southern and western Korea.

Among the species enumerated from Fusan are some closely related to those on the Japanese shore, yet distinct from their nearest allies. The majority of the species are, however, of the ordinary Japanese types.

Dr. Jordan wishes to express his personal appreciation to General Terauchi, Governor General of Korea, and to Vice-governor Yamagata for assistance in this work. Governor Terauchi requested the co-operation of all the fishery inspectors. In this connection we desire to acknowledge the efforts of Mr. B. Ihara, Commissioner of Fisheries for Korea, Mr. T. Kikuchi, head of the Bureau of Education, Dr. K. Honda, Director of the Agricultural Experiment Station at Suwon, Mr. Eitaro Ijima of the Bureau of Finance at Seoul, a former student of the senior author, Mr. T. Wakamatsu, Governor of Fusan, and Mr. G. Yamaoka, collector of Customs at Fusan, who rendered especially valuable service.

The new drawings in this paper are the work of the late Sekko Shimada, and of Mrs. Herbert Charles Nash. The others are reprints from papers in the Proceedings of the United States National Museum. The vernacular names are given by Mr. Ihara. Unless otherwise specified they are the Japanese (not Korean) names.

Ten species are new: *Spirinchus verecundus, Rhodeus chosenicus, Pseudoperilampus hondæ, Parapelecus eigenmanni, Pseudaspius bergi, Pseudaspius modestus, Epinephelus ionthas, Sciæna iharæ, Pleurogrammus azonus, Sebastodes ijimæ, Areliscus hollandi.*

Family EPTATRETIDÆ.

1. **Eptatretus burgeri** (Girard).

Fusan[1] (Jouy coll.).

[1] Throughout this paper the use of the words *Fusan, Chinnampo, Chemulpo, Suigen, Heijo,* without the citation of any other authority, indicates that specimens were seen or obtained at those localities by Dr. Jordan or by Mr. Ihara. (D. S. Jordan.)

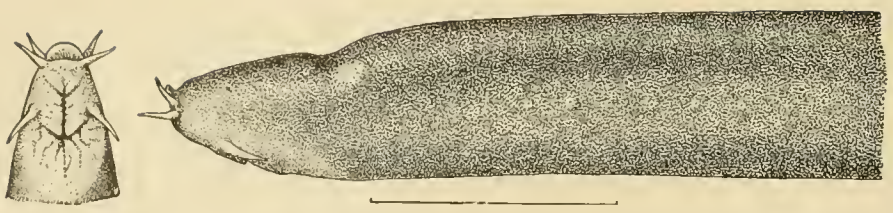


Fig. 1. *Eptatretus burgeri* (Girard). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIII, Plate XXX.)

Family HETERODONTIDÆ.

2. **Heterodontus japonicus** (Duméril). "Nekosame."
Fusan (No. 4491a).[1] (Jordan coll.)

Family GALEORHINIDÆ.

3. **Triakis scyllium** Müller & Henle. "Shirosame."
Fusan, Chinnampo (Nos. 4362a, 4490a).

4. **Cynias manazo** (Bleeker). "Hoshisame."
Jinsen (No. 4492a).

Family SPHYRNIDÆ.

5. **Sphyrna zygæna** (Linnæus). "Shimokusame."
Fusan (No. 4470a).

Family SQUALIDÆ.

6. **Squalus mitsukurii** Jordan & Fowler. "Tsunozame."
Chinnampo (No. 4359a).

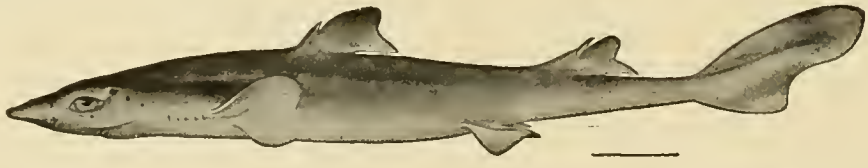


Fig. 2. *Squalus mitsukurii* Jordan & Fowler. (Proc. U. S. N. M., Vol. XXVI, p. 630.)

7. **Squalus japonicus** Ishikawa.
Chinnampo.

This species is distinguished from the common dog-fish or "Tsunozame" of Japan (*Squalus mitsukurii*) by the sharper and less obtuse snout, and by the

[1] Numbers in brackets after a locality indicate that the specimens in the Carnegie Museum from that locality bear the numbers given. Numbers given after a list of localities indicate that the specimens may have come from the localities named, or that they may simply have attached to them the general locality-label "Korea." (All those thus labelled came from Fusan, according to Dr. Jordan.) (C. H. Eigenmann, *Curator*.)

difference in the insertion of the first dorsal spine. The dorsal in *Squalus mitsukurii* is a little nearer the tip of the snout than the second dorsal. In *Squalus japonicus* the first dorsal is midway between the tip of the snout and the second dorsal, the pectoral reaching it.

Family SQUATINIDÆ.

8. **Squatina japonica** Bleeker. "Korosame."
Fusan (No. 4472a).

Family RHINOBATIDÆ.

9. **Rhinobatus schlegeli** Müller & Henle. "Sagatazame."
Fusan (No. 4476a).

Family RAJIDÆ.

10. **Raja kenojei** Müller & Henle. "Gangiei."
Port Arthur (Abbott). This is apparently *Raja chinensis* Basilewsky (*Ichthyographia Chinæ Borealis*, 1855, p. 251, from off Peking).

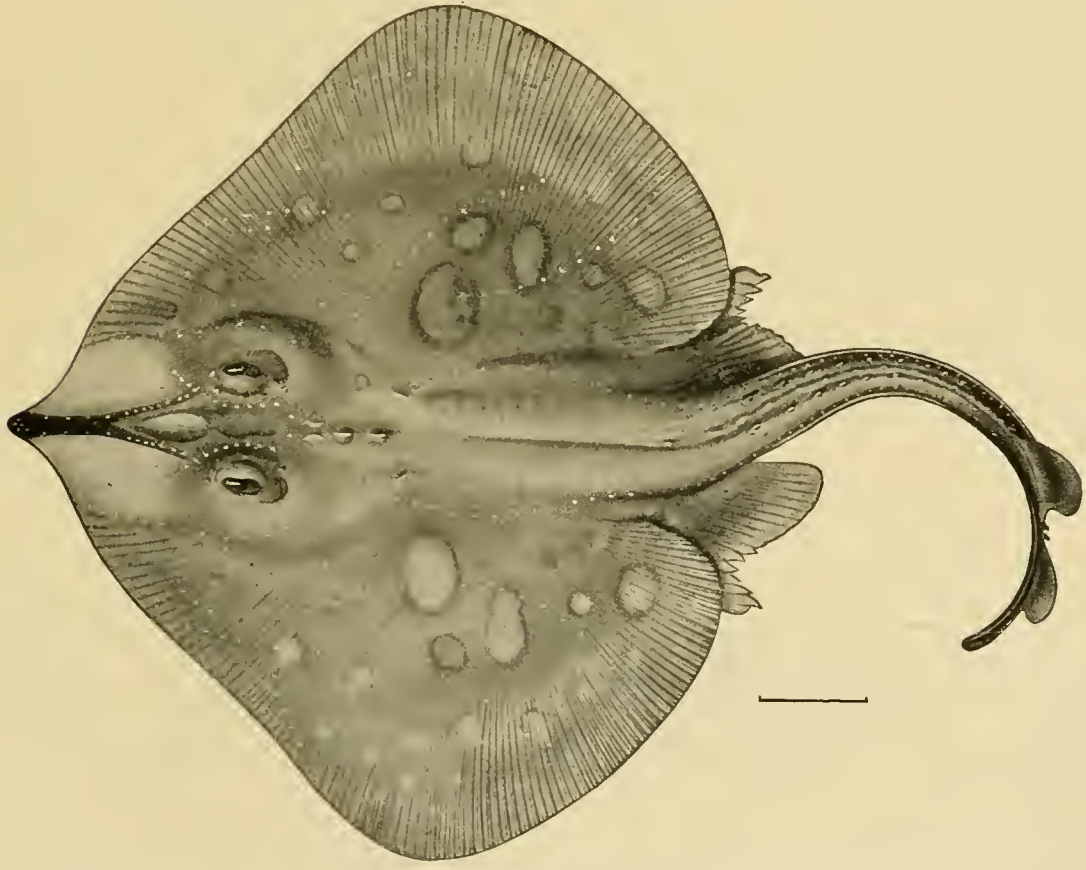


Fig. 3. *Raja meerdervoorti* Bleeker. (After Jordan & Fowler, Proc. U. S. N. M., Vol. XXVI, p. 651.)

11. **Raja meerdervoortii** Bleeker. "Gangici."
Fusan (No. 4471a).

Family DASYATIDÆ.

12. **Urolophus fuscus** Garman. "Shiroei."
Fusan (No. 4474a).

13. **Dasyatis akajei** (Schlegel). "Akaei."
Fusan (No. 4477a).

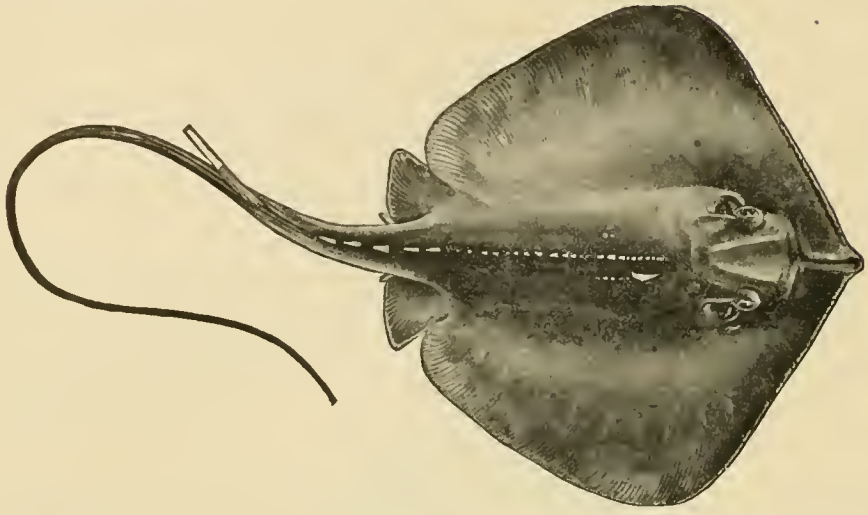


Fig. 4. *Dasyatis akajei* (Schlegel). (After Jordan & Evermann, Proc. U. S. N. M., Vol. XXV, p. 319.)

14. **Pteroplatea japonica** Temminck & Schlegel. "Yokosaei."
Fusan (No. 4475a).

Family MYLIOBATIDÆ.

15. **Myliobatis tobijei** Bleeker. "Tobiei, Hatoei."
Fusan (No. 4473a). This is apparently Basilewsky's *Myliobatis rhombus* (*Ichthyographia Chinæ Borealis*, p. 250) from the sea about Tientsin.

Family CLUPEIDÆ.

16. **Clupea pallasi** Cuvier & Valenciennes. "Nishin."

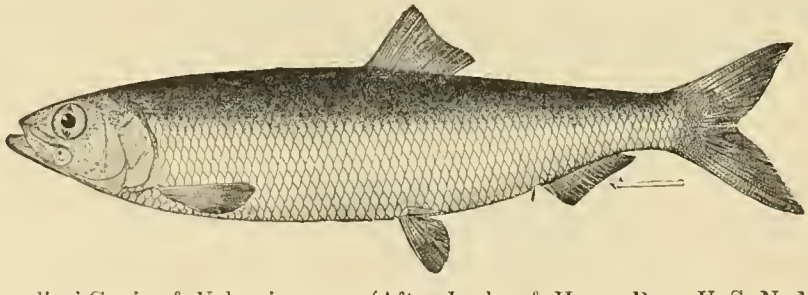


Fig. 5. *Clupea pallasi* Cuvier & Valenciennes. (After Jordan & Herre, Proc. U. S. N. M., Vol. XXXI, p. 631.)

Seen in Fusan. Also from Chinnampo (Nos. 4102a–e; 4130a). This is apparently *Clupea inermis* Basilewsky (p. 242) from about Tientsin.

17. **Amblygaster melanostictum** (Temminck & Schlegel). "Iwashi."
Fusan.

18. **Sardinella zunasi** (Temminck & Schlegel). "Zunashi."
Fusan, Chinnampo (Nos. 4228a–l).

19. **Ilisha elongata** (Bennett). "Hira."
Fusan, rather common (No. 4487a–b).

20. **Etrumeus micropus** (Temminck & Schlegel). "Urumeiwashi" adult; "Tsunashi" young.
Fusan, Jinsen; common (No. 4539a–j).

ZUNASIA gen. nov.

The species described by Basilewsky under the name of *Pristigaster chinensis* has not been noted by any subsequent author. It is the type of a new genus, *Zunasia* Jordan & Metz, allied to *Pristigaster*, but differing in the form of the body, the belly not forming the gibbous arc of a circle, being only moderately curved. The dorsal, as in *Pristigaster*, is inserted before the anal, near the middle of the body. The ventrals are wanting, as in *Pristigaster* and *Opisthopterus*. The type of *Pristigaster* is *P. cayanus* from Guiana and northern Brazil. No second species of *Pristigaster* is known.

The name *Zunasia* is derived from "Zunashi," the vernacular name of the related *Sardinella zunasi*.

21. **Zunasia chinensis** (Basilewsky). (Plate I, fig. 1.)
Pristigaster chinensis Basilewsky, *Ichthyographia Chinæ Borealis*, 1855, p. 243. (Gulf of Pechili.)

The following description of *Zunasia chinensis* Basilewsky is founded upon three specimens from 4.5 to 5.5 inches long, taken at Chinnampo, Korea, and cataloged in the Carnegie Museum under No. 4569:

D. 17 to 18; A. 48; scutes in front of vent 36; depth 3.66; head 4.5; eye 3 in head; snout 3.5; interorbital 7.5; maxillary 2.33. Body elongate, rather slender, greatly compressed, deepest behind apex of pectoral. Dorsal outline a gentle, even curve from nape to caudal; ventral outline more convex. Belly from gill-openings to vent slightly (not greatly) arched, the depth of the convexity being much less than the diameter of the eye, armed with thirty-six

sharp scutes. Head compressed, lower jaw large, projecting, entering dorsal profile, which is straight to nape, then rises in a gentle curve; occipital region with a long narrow, V-shaped groove, the two bounding ridges of which unite before the eye. Mouth terminal, moderate, very oblique; maxillary reaching beyond anterior margin of pupil; premaxillary distinct, fixed; teeth extremely minute, villiform in both jaws; gill-rakers numerous, long, slender; eye large, elevated, upper edge of pupil on a level with the apex of the mandible. Scales deciduous, rubbed off of our specimens, probably about sixty in number.

Dorsal short, inserted midway between the tip of the snout and the base of the caudal; anal long, inserted under the posterior third of the dorsal, extending to a point within diameter of eye from origin of caudal; caudal deeply forked, apparently not filamentous; pectorals small; ventrals wanting.

Color dusky brown above, silvery below; all fins pale; caudal with traces of black on marginal rays.

Family DOROSOMATIDÆ.

22. **Konosirus punctatus** (Temminck & Schlegel). "Konoshiro."
Fusan (No. 4527a–l).

23. **Konosirus nasus** (Bloch).
Chinnampo (No. 4227a).

Family ENGRAULIDÆ.

24. **Engraulis japonicus** Temminck & Schlegel.
Fusan.

25. **Setipinna gilberti** Jordan & Starks.
Fusan; very common.

26. **Trichosoma hamiltoni** (Gray).
Fusan, Chinnampo. (No. 4528, thirty specimens from Fusan, all marked "Korea.") (No. 4133a–e.)

27. **Coilia nasus** Temminck & Schlegel. "Etsu."
Port Arthur (Abbott); Chinnampo (No. 4137a).

28. **Coilia ectenes** Jordan & Seale. "Etsu."
Fusan, Chemulpo (No. 4515a–b).

This species differs from *Coilia nasus* of Southern Japan in the much larger number of fin-rays (123 instead of 81 in the anal). The number of dorsal

rays in the original description (113) is a misprint. The species is common on the sandy shores at Fusan and Chemulpo.

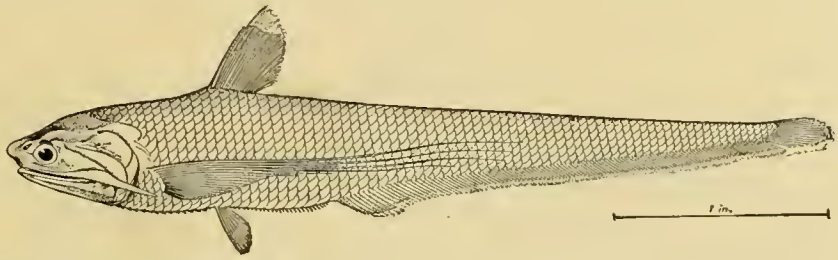


Fig. 6. *Coilia ectenes* Jordan & Seale. (Proc. U. S. N. M., Vol. XXIX, p. 518.)

Family SALMONIDÆ.

29. **Oncorhynchus masou** Brevoort. "Masu."
Chinnampo (No. 4355a).

30. **Oncorhynchus gorbuscha** (Walbaum).
Korea (Berg).

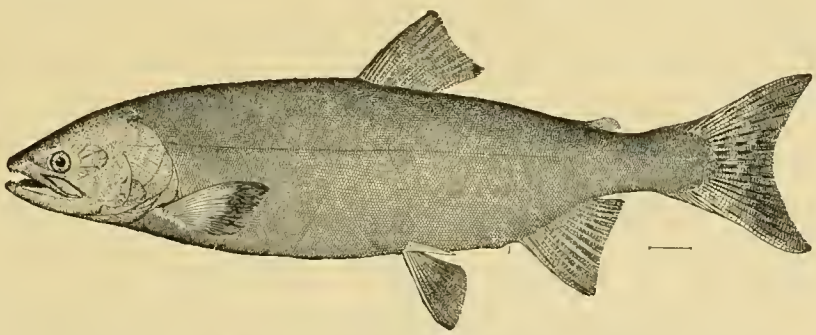


Fig. 7. *Oncorhynchus gorbuscha* (Walbaum). (After Jordan & Evermann, Bull. U. S. N. M., 47, Pt. IV, Plate 77, fig. 205.)

31. **Oncorhynchus keta** (Walbaum). "Sake."
Korea (Berg).

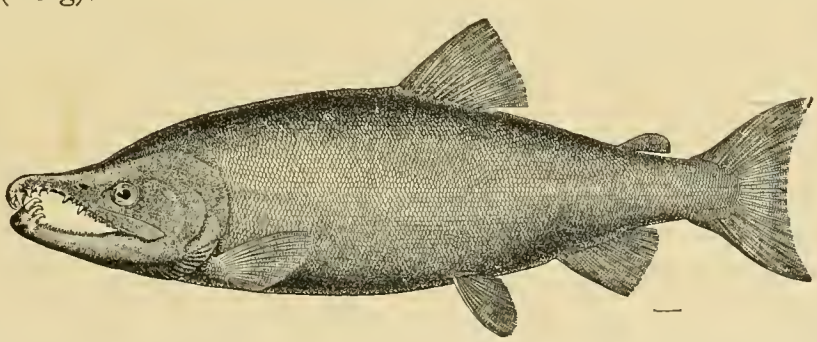


Fig. 8. *Oncorhynchus keta* (Walbaum). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 573.)

32. **Plecoglossus altivelis** Temminck & Schlegel. "Ayu."
Tsushima, Fusan (No. 4541a–c), Seoul, Yalu River.

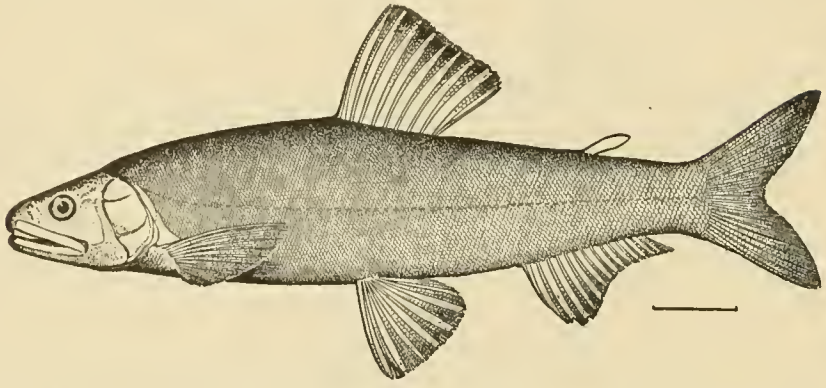


Fig. 9. *Plecoglossus altivelis* Temminck & Schlegel. (After Jordan & Evermann, Proc. U. S. N. M., Vol. XXV, p. 328.)

The common Ayu is very abundant in all the rivers of Korea, including the Yalu. Our specimens are from Fusan, and unusually large. It has not been hitherto definitely recorded from the continent of Asia, and the limits of its range are not known.

Family ARGENTINIDÆ.

33. **Osmerus dentex** Steindachner.
Chinnampo (No. 4225a–b).

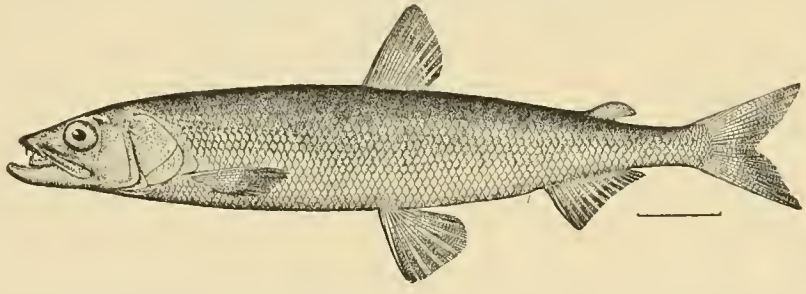


Fig. 10. *Osmerus dentex* Steindachner. (After Jordan & Evermann, Bull. U. S. N. M., No. 47, Pl. LXXXVI, fig. 229.)

Dr. Berg (*Ichthyologia Amurensis*, p. 58) places *Salmo inghaghitsh* of Walbaum (Artedi Piscium, p. 73) as a doubtful synonym of *Osmerus dentex*. As the teeth are said to be very small ("dentes minimi") it is not likely that this can be an *Osmerus*. It can only be *Mesopus olidus*, which according to Pallas is called "Inniacha" in Kamchatka. In that case the latter species should stand as *Mesopus inghaghitsh*.

34. **Spirinchus verecundus** sp. nov. (Plate I, fig. 2.)

Type No. 4570, 5.75 inches, Chinnampo, Korea; cotype, No. 4097.

Allied to *Osmerus* or *Spirinchus thaleichthys* Ayres, from the coast of California.

D. 10; A. 13; V. 8; scales 6–64; depth 5.6; head 5.5; eye 3.66 in head; snout 3.66; interorbital 3.66; maxillary 2.5; number of branchiostegals 7; gill-rakers numerous, slender, about 12–24; lateral line median. Teeth on vomer, palatines, and tongue moderate, canine-like, none of them very large, those on jaws very minute. Body slender, compressed, long; dorsal and ventral outlines similar; head rather stout, flat on top; snout bluntly pointed; lower jaw slightly projecting; mouth rather large; maxillary reaching pupil; eye moderate, elevated, nearer tip of snout than gill-opening. Scales rather small, cycloid, none on head.

Dorsal short, rather high, inserted midway between tip of snout and base of caudal; third ray longest, 1.33 in head; distance between insertion of dorsal and adipose dorsal exactly one-third the length of the body; caudal deeply emarginate; pectoral moderate, 1.33 in head, reaching slightly over half-way to ventrals; ventrals inserted under anterior third of dorsal, reaching half-way to anal; anal short, inserted two-thirds of its length before adipose dorsal.

Color dusky above, darkest on back and in a stripe along lateral line; under parts and all fins pale.

Described from three specimens 5.75 inches in total length, taken at Chinnampo, Korea. The type is Number 4570 in the Carnegie Museum. A cotype is in the collection of Stanford University.

Family SALANGIDÆ.

35. **Salanx hyalocranius** Abbott. "Shirano."

Chinnampo, River Kanko, near Fusan (No. 4253a–d and 4524a–g). Otherwise known only from about Tientsin. Locally abundant. This species is *Eperlanus chinensis* of Basilewsky (*Ichthyographia Chinæ Borealis*, 1855, p. 242), but the name *chinensis* is preoccupied in *Salanx*, for the "Whitebait" of Southern China.

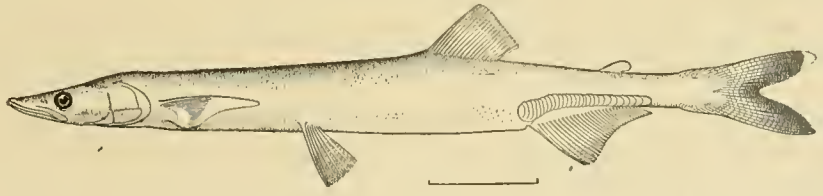


Fig. 11. *Salanx hyalocranius* Abbott. (Proc. U. S. N. M., Vol. XXIII, p. 491.)

Family SYNODONTIDÆ.

36. **Saurida eso** Jordan & Herre. "Eso."
Fusan; common in the markets (No. 4557a).

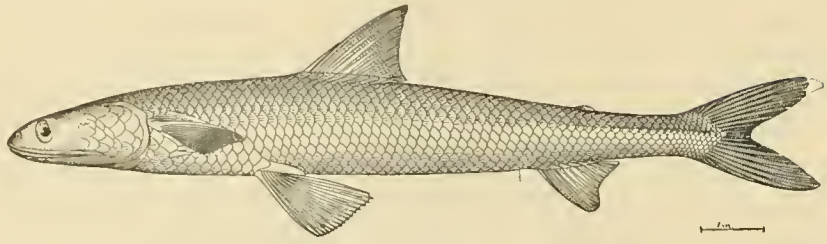


Fig. 12. *Saurida eso* Jordan & Herre. (Proc. U. S. N. M., Vol. XXXII, p. 520.)

Family SILURIDÆ.

37. **Parasilurus asotus** (Linnæus). "Namazu" (Korean name "Chyagasari").
Han River at Seoul, Kanko River (No. 4529a–e); Heijo, Suigen (No. 4361a).

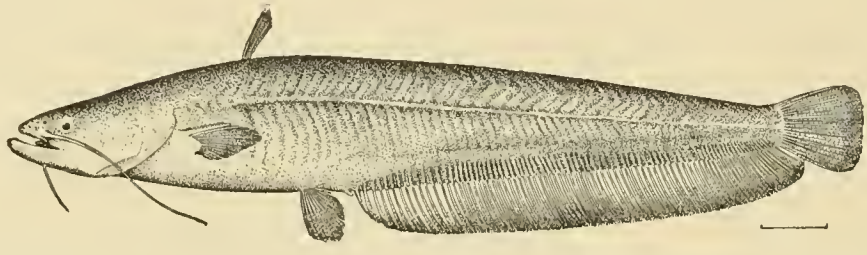


Fig. 13. *Parasilurus asotus* (Linnæus). (After Jordan & Evermann, Proc. U. S. N. M., Vol. XXV, p. 320.)

38. **Fluvidraco fulvidraco** (Richardson). (Korean name "Chyagasari.")
Silurus calvarius Basilewsky.
Seoul (Steindachner); Suigen (No. 4343a).

39. **Leiocassis longirostris** (Günther).
Han River, Seoul (Steindachner).

Family COBITIDÆ.

40. **Cobitis sinensis** Sauvage. "Shimadozo" (Korean name "Chigorunchen").
Suigen, Gensan (No. 4148a); Fusan (Jouy); Pungtung (Herz).

41. **Lefua costata** Kessler.
Elxis corcanus Jordan & Starks, Proc. U. S. Nat. Mus., Vol. XXVIII, 1905, p. 201.

Gensan, Fusan (Jouy); Gensan (Schmidt); Chinnampo (No. 4177, 145 specimens).

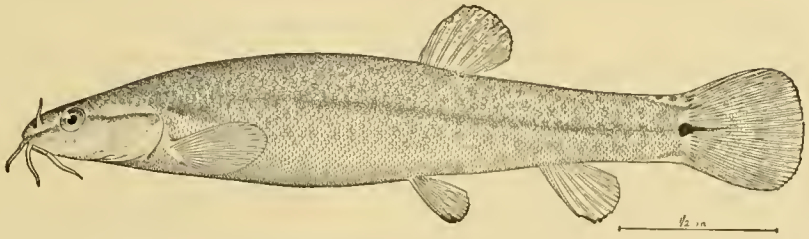


Fig. 14. *Lefua costata* Kessler. (After Jordan & Starks, Proc. U. S. N. M., Vol. XXVIII, p. 202.)

This species seems locally very abundant.

42. **Oreias toni** (Dybowsky).

Pung-tung (Herz).

Description taken from ten specimens 2.5–4.5 inches long, collected at Chinnampo, Korea (No. 4142a–k):

D. 9; A. 7; pores in lateral line about 95; head in length 4.8; depth 8.5; depth of caudal peduncle in head 1.25; eye 6; snout 2.33; interorbital 4.25; pectoral 1.60. Barbels six, four of them close together on snout, one on apex of each maxillary; nostrils small near eye, anterior with a flap; scales small, imbedded, not imbricated, apparently lacking on head; lateral line median; gill-openings confined to sides, not extending forward, separated by broad isthmus. Body long, slender, not compressed, uniform in depth from shoulder to vent; caudal peduncle compressed, its width at base 1.66 in its depth; head long, slightly compressed, conical, tapering to the bluntly rounded, projecting snout; mouth inferior, small; maxillary reaching to below anterior nostril, not nearly to eye; all barbels long, about equal to snout; eye small, elevated, about midway in length of head.

Dorsal short, rather high, apex rounded, inserted nearer the tip of the snout than the base of the caudal by a distance equal to length of snout; caudal very slightly emarginate; pectorals short, rounded; ventrals inserted very slightly in front of dorsal, not reaching vent; anal short, high, inserted well behind vertical from tip of depressed dorsal, half the length of head behind the last dorsal ray.

Color in spirits dusky above lateral line, irregularly blotched with darker areas, most of which are much larger than eye; sides below lateral line lighter, with indistinct blotches; ventral surface white. Top of head dark, with irregular light specks; sides of head mottled and freckled, with a dark stripe from eye to tip of snout. Dorsal spotted, the spots forming four irregular bars;

caudal similar, the spots scarcely arranged in bars; pectoral mottled apically, the spots in two irregular bars. A series of ten specimens shows great variation in color; the blotches on the upper parts of some specimens arranged in zigzag, transverse bars, extending well down on the sides below the lateral line; others are pale, with large distinct, round blotches on back and sides.

According to Dr. Berg, *Oreias dabryi* Sauvage (Revue & Mag. Zool., XXXVIII, 1874, p. 334) from China is generically identical with *Orthrias* Jordan and Fowler (*O. oreas*) of later date. Dr. Berg regards *Oreias* as a subgenus of *Nemachilus*, from which it is separated by the short dorsal and subtruncate caudal.

43. **Misgurnus anguillicaudatus** (Cantor). "Dojo" (Korean name "Mikkukurru").

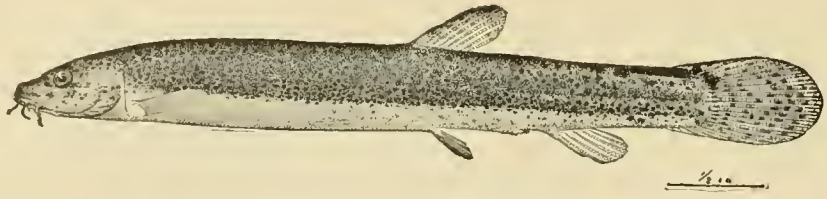


Fig. 15. *Misgurnus anguillicaudatus* (Cantor). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXX, p. 834.)

Kanko River (No. 4518a–j), Fusan; everywhere common. Chinnampo, Suigen (No. 4205a–j), Heijo.

According to Dr. Berg, *Misgurnus decemcirrosus* Basilewsky is not distinct from this species, as Jordan & Snyder have supposed.

Family CYPRINIDÆ.

44. **Cyprinus carpio** Linnæus. "Koi" (Korean name "Ing-o").
Korea, common everywhere (Nos. 4526a–c, 4556a–c).

45. **Carassius auratus** (Linnæus). "Funa" (Korean name "Ping-o").
Everywhere in the rivers (No. 4340a–d, 4364a).

46. **Hemibarbus maculatus** Bleeker.
Hemibarbus maculatus Bleeker, Verh. Akad. Amst., XII, 1871, p. 19, taf. IV, fig. 8. Yangtsekiang.
Barbus semibarbus Günther, Ann. & Mag. Nat. Hist., 1889, p. 224 (substitute for *maculatus*, preoccupied in *Barbus*).

Hemibarbus joiteni Jordan & Starks, Smithsonian Miscellaneous Collections, XLV, 1904, plate LXIV; Tientsin.

Acanthogobio paltschevskii, Nicolsky, Ann. Mus. Zool. Petersb., VIII, 1904, p. 356. Ussuri River, Chanka Lake.

Heijo (No. 4186a–b).

Three specimens from Heijo, Korea, yield the following notes:

D. III, 7; A. 8; scales 8–50; depth 4.6; head 3.6; eye 4; snout 2.25; maxillary 3.11; interorbital 4.25 in head. Body slender, deepest under first dorsal spine; dorsal outline gently rounded, convex from snout to dorsal, thence sloping rapidly to posterior part of dorsal and then very gradually to caudal; ventral outline almost straight from snout to ventrals, thence sloping to caudal; dorsal inserted above tip of pectoral, well before ventrals; ventrals reaching half-way to anal; anal high, but not reaching caudal when depressed. Mouth inferior; snout projecting slightly above; barbels on maxillary slightly less than diameter of eye.

Dorsal very high, third spine equal to depth of body; last soft ray two-fifths length of first, which is equal to third spine; caudal emarginate; ventrals and pectorals narrow, pointed; dorsal pale with dark tip; caudal dusky, darker mesially; remaining fins pale. Body pale below lateral line, dusky above; all scales on back and sides above the level of the pectoral dark-edged, producing a lattice-work effect.

This species is close to *Hemibarbus barbus* (Schlegel) from Japan, but is certainly distinct. Dr. Berg identified *Hemibarbus barbus* with *Hemibarbus labeo* (Pallas) from Siberia. On this question we have no opinion. We have seen no specimens of *Hemibarbus barbus* from outside of Japan.

47. **Hemibarbus labeo** (Pallas).

Seoul (Steindachner) as *Barbus schlegeli;* Fusan (Berg).

We have not seen this species, and do not know whether it is identical with either the Japanese *Hemibarbus barbus*, or the Chinese *Hemibarbus maculatus*.

48. **Pseudogobio esocinus** Temminck & Schlegel.

Chinampo (No. 4136a).

We refer our specimens to this common Japanese species. The snout in Korean examples is somewhat shorter, and the lips a little less papillose, but we find nothing to warrant specific distinction.

49. **Pseudogobio rivularis** (Basilewsky).

Pseudogobio sinensis Kner.

This species from about Tientsin is close to *Pseudogobio esocinus*. A small specimen (No. 4310a) from Suigen may belong to it.

50. **Gnathopogon**[3] **coreanus** (Berg).

Sambusan River, South Korea (Berg).

51. **Pseudorasbora parva** Temminck & Schlegel.

(Korean name "Torukoki.")

Description based upon six specimens, the largest three inches in length, taken at Suigen, Korea:

D. 9; A. 8; scales 6–38; depth in length 4.33; head 4.25; depth of caudal peduncle in head 2; eye 3.5; snout 3; maxillary 4; interorbital 3.33; pectoral 1.5; pharyngeal teeth 5, in a single row, long, slender; gill-openings extending a short distance forward below; separated by a narrow isthmus; lateral line complete; slightly decurved. Body elongate, moderately deep, deepest at insertion of dorsal; back elevated from nape to dorsal descending rapidly under dorsal fin; ventral outline evenly slightly convex from snout to anal, then slightly concave; caudal peduncle compressed, rather slender; head broad, depressed, flattened above; snout pointed; mouth very short, broad, oblique; lower jaw slightly projecting; nostrils close together near eye; maxillary short, not reaching to below nostrils, scarcely half-way to eye; scales large, cycloid, lacking on head.

Dorsal short, high, inserted midway between snout and caudal at apex of back; longest rays equal to length of head; caudal deeply forked; pectoral short; narrowly rounded; apex falling short of ventral base by a distance equal to diameter of eye; ventrals inserted under second dorsal ray, short, not reaching anal, which is inserted behind last dorsal ray a distance equal to two-fifths of head, and reaches about half-way to the base of the caudal when depressed.

Color on top of head and back dark; scales on sides above level of pectorals each with a large, vertical, crescentic area of dusky, producing a spotted effect; a dark band, equal in width to the diameter of the eye, extends from tip of snout through eye to base of caudal; under parts and all fins pale.

This species is not distinguishable from *Pseudorasbora parva*, the common "Moroko" of the rivers of Japan.

52. **Gonoprokopterus mylodon** (Berg).

(*Barbus mylodon* Berg, 1907.)

Keumsan near Fusan (Berg).

[3] *Gnathopogon* Bleeker. Ichth. Archipel. Indic. Prodr., II, 1860, p. 434: type *Capocta elongata* Schlegel = *Leucogobio güntheri* Ishikawa.

53. **Ladislavia taczanowskii** Dybowsky.
Pung-tung (Herz).

54. **Saurogobio athymius** (Jordan & Starks).

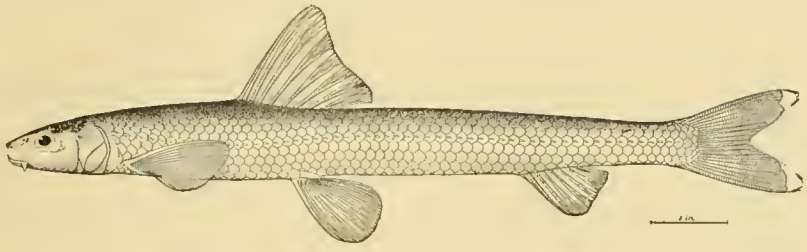


Fig. 16. *Saurogobio athymius* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 196.)

Chemulpo (Jouy).

Dr. Berg is quite right in considering the genus *Longurio* based by Jordan and Starks on this species, as identical with *Saurogobio* Bleeker, based on *S. dumerili* Bleeker from China.

55. **Coreius cetopsis** (Kner).
Chemulpo (Jouy).

56. **Pungtungia herzi** Herzenstein.
Pung-tung (Herz).

The genus *Pungtungia* obviously differs from *Pseudorasbora* in the presence of well-developed barbels. It differs from *Gnathapogon* (=*Squalidus* Dybowsky), in the low, produced snout and short oblique mouth; teeth 5–4; scales 40.

57. **Aphyocypris ensarca** (Jordan & Starks).
Fusan (Jordan & Starks).

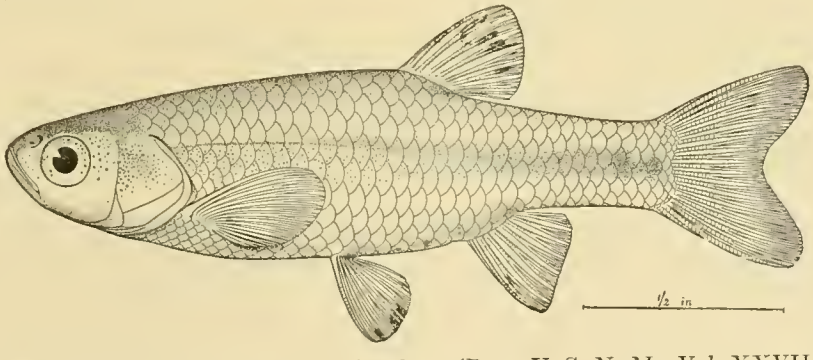


Fig. 17. *Aphyocypris ensarca* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 199.)

Dr. Berg is quite right in uniting the genus *Fusania*, established by Jordan and Starks for this species, with *Aphyocypris*, based by Dr. Günther on *A. chinensis*.

58. **Richardsonius hakuensis** (Günther). "Ugiu."

Kanko River, Fusan, Chinnampo (No. 4360a–c) (No. 4514a–c). Abundant.

Breeding males with two rather narrow orange stripes on each side from head to tail, one along the back and one along the side of the belly. Since, according to Professor Cockerell, none of the American or Japanese species usually referred to *Leuciscus* are congeneric with the European dace, *Leuciscus leuciscus* (Linnæus), we adopt for the group the oldest of the American names. The scales of *Richardsonius* are said to differ materially from those of *Leuciscus*.

59. **Richardsonius brandti** (Dybowsky).

Chinnampo (No. 4110), Gensan (Jordan & Starks, as *L. taczanowskii*). According to Dr. Berg *brandti* and *taczanowskii* are identical.

60. **Richardsonius semotilus** (Jordan & Starks).

Fusan (Jouy); Gensan (Schmidt).

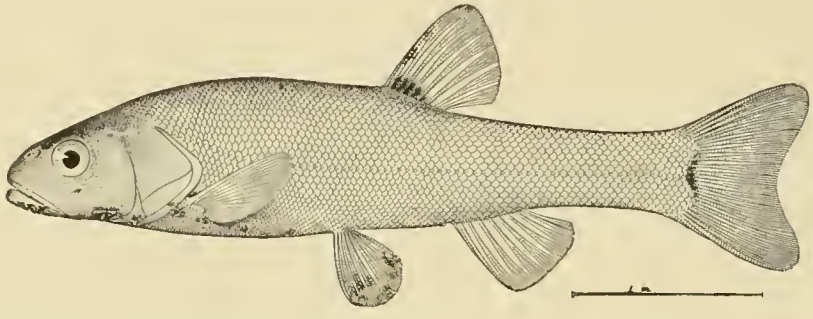


Fig. 18. *Richardsonius semotilus* (Jordan & Starks). (Proc. U. S. N. M., Vol. XXVIII, p. 200.)

61. **Richardsonius jouyi** Jordan & Snyder.

(*Leuciscus dorobaë* Ishikawa.)

Sasuma, island of Tsushima.

62. **Hemitremia lagowskyi** (Dybowsky).

Gensan (Schmidt).

According to Professor Cockerell the scales of the European species of *Phoxinus* differ generically from those of the East Asian and American forms referred to *Phoxinus*. We therefore use the name *Hemitremia* for the American and Japanese forms.

63. **Acheilognathus coreanus** Steindachner.

Seoul (Steindachner).

64. **Acheilognathus signifer** Berg.

Pung-tung (Herz).

65. **Acanthorhodeus asmussi** Berg. (Plate II, fig. 1.)

Jeijo. (Korean name "Nazegi.")

A fine large specimen of this handsome genus (No. 4571) obtained at Heijo we refer with some doubt to *Acanthorhodeus asmussi* (Dybowsky) (Verh. Zool.-Bot. Ges., Wien, XXII, 1872, p. 212, Chanka Lake), as noted by Berg in his *Ichthyologia Amurensis.*

Description of two specimens 5.5 inches in total length, taken at Heijo, Korea: D. II, 18; A. II, 13; depth 2.25; head 4.5; eye 3.5; snout 3.5; maxillary 4; interorbital 2.5; scales 7, 40, 6. Maxillary with very small rudimentary barbel at tip; lateral line complete, decurved, slightly below median line; pharyngeal teeth 5–5, sharp, curved and claw-like; body deep, compressed, deepest through origin of dorsal; ventral outline evenly curved from snout to caudal peduncle, less strongly arched than dorsal outline, which is very high; head low; profile from tip of snout to nape almost straight; nape high; snout blunt; eye large, elevated; mouth small, inferior; maxillary not reaching front of eye; nostrils large, very closely approximated, and near eye.

Scales very large on sides, smaller below; head naked; dorsal and anal with sheath of large scales at base, none on membrane; dorsal fin long, not high, inserted midway between tip of snout and base of caudal; first two rays spine-like, second longest, 1.16 in head; dorsal rays gradually shortened to last which is 2.33 to 3 in first; anal similar to dorsal, inserted under tenth dorsal ray; second ray spine-like, as large as second dorsal ray; caudal emarginate; pectorals and ventrals small, the former not quite reaching the latter, which are inserted slightly in advance of dorsal and reach almost to anal.

Color dusky above, black on top of head and median line of back; paler below, white on ventral parts; scales above level of pectoral dark-edged; a black band from base of tail along middle of side, becoming narrower and elevated anteriorly, ending in a distinct black blotch, slightly larger than pupil, a short distance behind opercle; all fins pale; dorsal with traces of dusky longitudinal bars; caudal with a few irregular jet-black spots.

This species is somewhat similar to *Acanthorhodeus guichenoti* Bleeker, but is more slender and has longer spine-like rays in dorsal and anal, and conspicuous black markings which are lacking in the latter.

66. **Rhodeus chosenicus** sp. nov. (Plate II, fig. 2.) (Korean name "Sogusari.")

Type, No. 4567 and cotypes 4568a–b, the largest 1.84 in. Suigen, Korea.

D. 8; A. 8; scales 30; depth 4; head 3.8 in length; eye 3.66 in head; snout 3.8; interorbital 2.8; pharyngeal teeth in one row 5–5, sharp, claw-like; gill-

rakers sparse, short; lateral line short, descending, incomplete; body elongate, not greatly compressed, slender, deepest through middle of pectorals; dorsal and ventral outlines similar; head depressed, broad, flattened on top; snout bluntly pointed; mouth terminal, oblique; maxillary reaching eye, which is large, slightly elevated; dorsal inserted nearer base of caudal than tip of snout by half the length of head, short, high; longest ray 1.33 in head; caudal deeply forked; pectoral short, not reaching ventrals, which are inserted slightly before dorsal and extend to vent; anal short, high, inserted behind last dorsal ray; longest ray equal to length of ventrals, reaching half-way to caudal when depressed; caudal peduncle almost as long as head, uniform in depth, which is half its length; scales cycloid, scarcely smaller on belly.

Color in spirits dusky on upper parts, black on top of head and median line of back, lighter below; scales on middle of sides with dusky patches, faint indication of posterior lateral stripe in some specimens; fins all pale.

Described from six specimens, the type largest, 1.84 inches in total length, taken at Suigen, Korea. The type is number 4567 Carnegie Museum; a cotype is in the Stanford University collection.

67. **Rhodeus ocellatus** Günther. (Korean name "Nazegi.")

Suigen, four specimens (No. 4299a–e).

This little fish is in color almost exactly like *Acanthorhodeus asmussi*, but there is a black spot behind the shoulder, besides a long blue stripe along the caudal peduncle. It agrees fully with the original description, and its form and color are well shown in Bleeker's figure. (See *Cyprinoides de Chine*, p. 34, pl. VI, fig. 3.)

68. **Pseudoperilampus hondæ** sp. nov. (Plate II, fig. 3.)

Type No. 4566, 2 inches, Suigen, Korea.

D. III, 13; A. III, 11; scales 7–35; depth 2.8; head 3.8; eye 3.2; snout 4.5; interorbital 3.5; depth caudal peduncle 2.5; maxillary 4; peritoneum black; pharyngeal teeth 5–5, one-rowed, sharp, serrate.

Body moderately deep, greatest depth at origin of dorsal; dorsal and ventral outlines equally convex; anterior profile arched above pectorals, straight from nape to tip of snout; origin of dorsal slightly nearer tip of snout than caudal base; pectorals slender, reaching ventrals; ventrals inserted under first dorsal spine, reaching anal; dorsal fin rather high, longest ray 1.16 in head; anal inserted under sixth dorsal ray, similar to soft dorsal; caudal deeply forked; lateral line slightly below middle of side.

Color dusky on back, becoming lighter on middle of sides and white below; scales on upper parts dark-margined; dorsal and anal each with three narrow, black, longitudinal stripes, separated by similar pale stripes; caudal slightly dusky; other fins pale.

This species differs from *Pseudoperilampus typus* in the much larger scales, and the longer vertical fins.

Described from the type 2 inches in total length, taken at Suigen, Korea number 4566 in the Carnegie Museum.

Named for Dr. K. Honda, the director of the Agricultural Station at Suigen, who obtained for us a fine collection from the pond at this station.

69. **Opsariichthys bidens** Günther. (Korean name "Woi.")

Heijo (No. 4533a) (No. 4232a), Suigen; Seoul (Steindachner).

This species seems very close to the Japanese representative *O. uncirostris* (Temminck and Schlegel).

70. **Zacco temmincki** (Temminck & Schlegel).

Fusan (Jouy); Pung-tung (Herz).

71. **Squaliobarbus curriculus** (Richardson).

Seoul (Steindachner).

72. **Parapelecus jouyi** Jordan & Starks.

Chemulpo (Jouy).

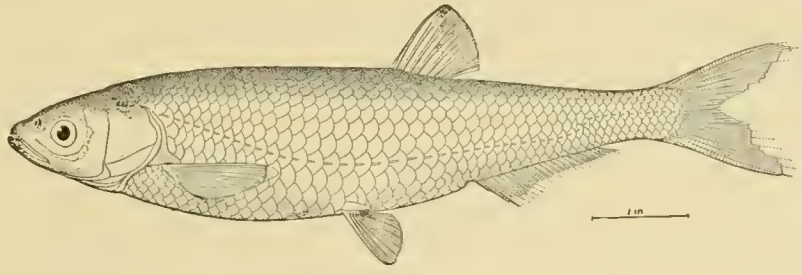


Fig. 19. *Parapelecus jouyi* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 201.)

73. **Parapelecus eigenmanni** sp. nov. (Plate III, fig. 1.)

Type No. 4565, 5.5 inches, Suigen, Korea.

D. 9; A. 15; scales in median series about 50; depth 4 in length; head 4.5; eye 4 in head; snout 4; interorbital 3; maxillary 3; pectoral 1; depth of caudal peduncle 2.5. Lateral line very low, with an abrupt anterior arch; body elongate, compressed, deepest in front of ventrals; back slightly elevated; ventral outline much more convex than dorsal; head broad, almost flat on top; dorsal

profile of head straight; snout high; mouth rather small, terminal, oblique; lower jaw included; maxillary reaching vertical from nostrils, not to eye; nostrils large, elevated, separated by a flap, nearer eye than tip of snout; eye large, slightly elevated, not entering profile; belly trenchant from below pectorals to vent, arched before and behind ventrals.

Dorsal fin inserted nearer base of caudal than tip of snout by a distance equal to half the head; first soft ray slightly longer than spine-like ray, almost equal to length of head; caudal deeply forked; lower lobe slightly the longer; pectoral long, pointed; first ray longest, reaching four-fifths distance to ventrals, which are inserted half their length before dorsal, and extend half way to anal; anal rather long and low; first rays twice the length of last, inserted under apex of depressed dorsal.

Color in spirits entirely pale, slightly dusky above; all fins pale.

Described from type and cotype, the former 5.5, the latter 3.75 inches in total length. The type was taken at Suigen, Korea, and is No. 4565 in the Catalog of the Carnegie Museum. It is named for Prof. C. H. Eigenmann.

74. **Pseudaspius bergi** sp. nov. (Plate III, fig. 2.)

Type No. 4563, 4 inches, cotypes 4091. Chinnampo, Korea.

D. 9; A. 8; scales 100 to 120 in lateral line, 53 to 60 before dorsal; head in length 4; depth 5; eye in head 4; maxillary 3; snout 3.66; interorbital 2.75; depth of caudal peduncle 2. Lateral line low, decurved, following ventral outline posterior to ventrals; body long, slender, not greatly compressed, dorsal and ventral outlines similar; caudal peduncle deep, compressed; head broad, depressed, flattened above, tapering to rather acute snout; no barbels; mouth rather large, oblique, terminal; maxillary reaching eye, nostrils close together, nearer eye than tip of snout; eye rather large, high; interorbital space broad, very slightly convex. Pharyngeal teeth two-rowed, 4, 2, 2, 4, the outer ones long, fang-like, curved at tips; gill-rakers rudimentary, gill-openings almost confluent, the isthmus very narrow; scales moderate, cycloid.

Dorsal inserted posteriorly, nearer base of caudal than tip of snout by a distance equal to half of head, rather high; longest ray 1.33 in head; caudal emarginate; pectorals small, rounded, 1.66 in head; reaching a trifle more than half-way to ventrals, which are inserted one-half their length before dorsal, and reach almost to anal; anal short, high, inserted just behind dorsal base, reaching half-way to caudal.

Color in spirits dusky, almost black on upper parts, pale on belly; dorsal, caudal, and tips of pectorals dark; other fins pale.

Described from six specimens, the type 4 inches, the rest 2.5 to 4 inches in total length, from Chinnampo, Korea. The type is number 4563 in the Catalog of the Carnegie Museum; a cotype is in the collection of Stanford University.

The genus, *Pseudaspius*, is visibly distinguished from other Korean minnows by the very small scales. It resembles the American genus *Rhinichthys*, but has no barbels.

Pseudaspius bergi is a strongly marked species, well separated from *Pseudaspius leptocephalus* (Pallas) from the Amur River. It is named for Dr. Leo S. Berg of the Museum at St. Petersburg, in recognition of his admirable "Ichthyologia Amurensis."

75. **Pseudaspius modestus** sp. nov. (Plate III, fig. 3.)

Type No. 4561, 2 inches; cotypes No. 4562. Chinnampo, Korea.

D. 9; A. 9; scales in lateral line about 82; head in length 3.5; depth 4.5; eye in head 3.66; snout 3.5; maxillary 3.25; interorbital 3.33; depth of caudal peduncle 3. Pharyngeal teeth two-rowed, 5, 2, 2, 5; lateral line decurved, rather below median line of side, less curved than ventral outline; body elongate, compressed, moderately deep, deepest in front of ventrals; caudal peduncle compressed, slender; head broad, depressed, flattened above; snout rather acute; mouth terminal, oblique; cleft reaching front of eye; no barbels; eye large, elevated; nostrils close together, posterior, quite large, close to eye.

Dorsal short, high, anterior, inserted nearer tip of snout than base of caudal by a distance equal to two-fifths of head; longest ray 1.33 in head; caudal rather shallowly emarginate; pectorals low, short, 1.66 in head, not reaching ventrals, which are inserted one-third of their length before dorsal, and are short, barely reaching anal; anal short, high, inserted under next to last dorsal ray; scales rather small, cycloid, most distinct on sides.

Color in spirits dusky above; median line of back dark; a dark median line on sides posteriorly, becoming broader and less distinct in pectoral region; under parts and fins pale.

Described from ten specimens, the type two inches in total length taken at Chinnampo, Korea. The type is No. 4561 in the Catalog of the Carnegie Museum.

This species is easily distinguished from *Pseudaspius bergi* by its deeper body, slenderer caudal peduncle, fewer scales, etc.

76. **Culter recurviceps** (Richardson).

Chemulpo (Jouy).

77. **Culter ilishæformis** Steindachner.

Seoul (Steindachner).

Berg, perhaps correctly, identifies this with *Culter erythropterus* Basilewsky, from about Peking.

78. **Ochetobius lucens** Jordan & Starks.

Chemulpo (Jouy).

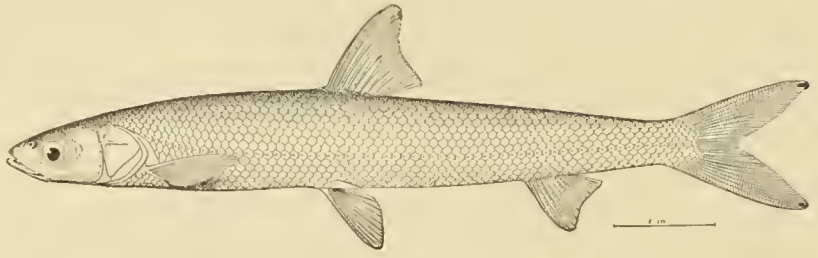


Fig. 20. *Ochetobius lucens* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 196.)

Family PŒCILIIDÆ.

79. **Oryzias latipes** (Temminck & Schlegel). "Kuaushin" (Korean name "Sogusari").

Fusan (Jouy); Suigen (No. 4210a–o).

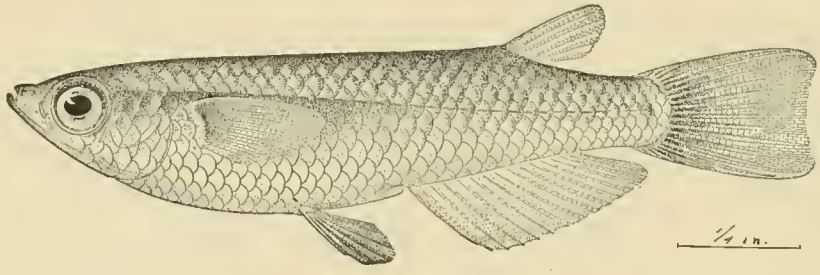


Fig. 21. *Oryzias latipes* (Schlegel). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXI, p. 290.)

Family MONOPTERIDÆ.

80. **Monopterus albus** (Zuieuw). (Korean name "Ugo.")

Suigen (No. 4164a).

(*Apterygia saccogularis* and *Apterygia nigromaculata* Basilewsky.)

Family ANGUILLIDÆ.

81. **Anguilla japonica** (Temminck & Schlegel). "Unagi" (Korean name "Penijan").

Fusan, Tsushima (Suigen No. 4123a; "Korea" 4495a–d).

Family LEPTOCEPHALIDÆ.

82. **Leptocephalus anago** (Temminck & Schlegel). "Anago."
Fusan market.

83. **Leptocephalus myriaster** (Brevoort).
Common in the market at Fusan.

Family MURÆNESOCIDÆ.

84. **Murænesox cinereus** (Forskål). "Hamo."
Fusan (No. 4498a–d).

Family OPHICHTHYIDÆ.

85. **Ophisurus macrorhynchus** (Bleeker).
Fusan ("Korea" No. 4536a).
This species may be the same as *Ophisurus serpens* of the Mediterranean.

Family BELONIDÆ.

86. **Tylosurus anastomella** (Cuvier & Valenciennes). "Datsu."
Belone esocina Basilewsky, *Ichthyographia Chinæ Borealis*, p. 260, from Shandun.
Fusan (No. 4484a–b).

Family HEMIRAMPHIDÆ.

87. **Hyporhamphus sajori** (Temminck & Schlegel). "Sayori."
Belone microstoma Basilewsky, *Ichthyographia Chinæ Borealis*, p. 260, Shandun.
Fusan (No. 4549a). Common; Chinnampo (No. 4158a).

Family EXOCŒTIDÆ.

88. **Cypselurus hirundo** (Steindachner). "Tobino."
One specimen, Fusan (No. 4304a).

Family SYNGNATHIDÆ.

89. **Syngnathus schlegeli** Kaup. "Yoji."
Chinnampo (No. 4309a–x); Gensan (Jouy).
The specimens are very slender, the snout 1.75 in head.

90. **Hippocampus chinensis** Basilewsky.

(*Ichthyographia Chinæ Borealis*, p. 249.)

Gulf of Pechili; "often seen dried in the markets of Peking." The description of Basilewsky gives no characters by which the identity of the species can be determined, among the numerous sea-horses found on the coasts of Japan and China.

Family AULORHYNCHIDÆ.

91. **Aulichthys japonicus** Brevoort.

Fusan (Jouy).

Family GASTEROSTEIDÆ.

92. **Pygosteus sinensis** (Guichenot).

Gensan (Jouy).

Family SPHYRÆNIDÆ.

93. **Sphyræna obtusata** (Cuvier & Valenciennes). "Kamasu."

Fusan, common; a fine food-fish ("Korea" 4553a–c).

Family MUGILIDÆ.

94. **Mugil cephalus** Linnæus. "Bora."

Mugil soiuy Basilewsky, *Ichthyographia Chinæ Borealis*, p. 226, pl. IV, fig. 3. ("Korea" 4544a–b, 4501a–c.)

Fusan, abundant. The Japanese species differs little, if at all, from the European *Mugil cephalus*.

95. **Liza hæmatochila** (Temminck & Schlegel). "Menada."

Common in Fusan market. Chinnampo (No. 4128); Chemulpo (Schmidt).

Family BERYCIDÆ.

96. **Beryx decadactylus** Cuvier. "Kimmedai."

Fusan.

Family SCOMBRIDÆ.

97. **Scomber japonicus** Houttuyn. "Saba."

Chinnampo (No. 4380a); Fusan (Korea 4543a–e).

98. **Auxis thazard** Lacépède. "Sodakatsu."

Fusan (No. 4478a). Common in the Tsushima Straits.

99. **Scomberomorus niphonius** (Temminck & Schlegel). "Sawara."

Fusan; a common food-fish.

100. **Scomberomorus sinensis** (Lacépède). "Sawara."

Fusan, common; valued as a food-fish.

101. **Acanthocybium sara** (Lay & Bennett). "Okisawara."

Abundant in the Straits of Tsushima. Specimens five to seven feet long are sent daily to the market at Seoul from Fusan. The large teeth are $\frac{18+18}{20+20}$.

The species of *Acanthocybium*, locally called "Ono," found at Honolulu, presumably the original *Acanthocybium solandri* (type from Tahiti), is a very distinct species, with much smaller teeth, $\frac{50+50}{50+50}$; the snout sharper, and the body slenderer. The huge size of these fishes makes it usually impossible to retain specimens. The existence of the two species in the Pacific renders it highly probable that the Atlantic species *Acanthocybium petus* (Poey) is distinct from both.

Family TRICHIURIDÆ.

102. **Trichiurus japonicus** Temminck & Schlegel. "Tachinono."

Chinnampo (No. 4183a–c), Fusan; Chemulpo ("Korea" 4485a–4494a–c).

One of the most abundant of the food-fishes especially valued by the Koreans. The flesh is pale and watery, without much flavor, but nutritious.

Family CARANGIDÆ.

103. **Trachurus japonicus** (Temminck & Schlegel). "Maazi."

Fusan ("Korea" 4555a–e). Not evidently different from the *Trachurus trachurus* or *semiarmatus* of the north of Europe.

104. **Seriola aureovittata** (Schlegel). "Buri."

Fusan; a common food-fish.

Family STROMATEIDÆ.

105. **Psenopsis anomala** (Temminck & Schlegel).

Fusan market.

Family STROMATEOIDIDÆ.

106. **Stromateoides argenteus** (Euphrasen). (Plate IV.)

"Manakatsuo." A common and valued food-fish (Fusan No. 4117).

This is the original *Stromateus argenteus* of Euphrasen, 1788, the *Stromateus aculeatus* of Cuvier & Valenciennes, differing from the common Chinese species

(*Stromateoides candidus*) (found also rarely in Japan) by its large number of fin-rays.

The Chinese species, abundant in Canton, is *Stromateus argenteus* of Bloch, 1794, which is the same as *Stromateus candidus* and *Stromateus securifer* of Cuvier & Valenciennes, and *Stromateus punctatissimus* of Schlegel. This species, distinguished by the falcate soft dorsal, with dorsal rays 41, and anal rays 39, should apparently stand as *Stromateoides candidus*. *Stromateus nozawæ* Ishikawa from the Bay of Tokyo is like *Stromateoides argenteus*, but differs apparently in the very high dorsal and anal, the lobes when depressed reaching the caudal.

The following is a description of *Stromateoides argenteus* (Euphrasen), taken from a specimen 185 mm. long, collected at Fusan, Korea: D. 46; A. 43; depth 1.45 in length; head 4.25; eye in head 4.5; snout 3.33. Mouth small, inferior, maxillary reaching to below front of pupil; dorsal beginning half-way between mouth and caudal peduncle; nape high; head sloping to the rounded, blunt snout; back sloping both ways from beginning of dorsal, the profile both anteriorly and posteriorly being nearly straight, but the former more abruptly sloping; dorsal high in front, fourth ray one-third longer than head, sloping abruptly to the fourteenth or fifteenth ray, which is less than one-third the length of the longest ray; anal similar, but with the anterior lobe higher (almost twice head), inserted well behind the origin of the dorsal; pectoral one and one-half times the length of the head, rounded; caudal deeply forked; caudal peduncle short, equal to the length of the last anal rays.

Color silvery below the lateral line, which runs high, following the outline of the back; upper parts above lateral line dusky, somewhat metallic; vertical fins margined with black.

We know of no other differences between this species and *Stromateoides candidus*, except that the latter has the dorsal rays 41 and the anal 39. The two are doubtless "geminate" species, *Stromateoides argenteus* being from the north and *Stromateoides candidus* from the south.

107. **Stromateoides echinogaster** (Basilewsky). (Plate V.)

Chinnampo (No. 4572); Port Arthur (Abbott).

This species is distinguished from *Stromateoides argenteus* by the inequality of the lobes of the caudal fin in the adult. In the young the upper lobe is nearly as long as the lower, but with increasing age the lower lobe is one-third to one-half longer than the other. The species is the geminate representative of *Stromateoides cinereus* Bloch, of India, differing chiefly in the increased number of fin-rays, being D. 44 to 46, A. 41 to 43 in *Stromateoides*

echinogaster; and D. 40, A. 38 in *Stromateoides cinereus*. The name *echinogaster* refers to the spinules in the œsophagus, common to all stromateoid fishes.

Description taken from eight specimens, 4.5 to 5.5 inches in total length, collected at Chinnampo, Korea:

D. 46; A. 43; depth 1.4; head 4.5; eye 3.33; snout 4; interorbital 2.4; pectoral 2.6 in body-length; depth of caudal peduncle 2.66 in head; longest dorsal ray 3.5 in body. Body rhombic, very deep and compressed, deepest under origin of dorsal; nape high; profile of head very steep; snout very blunt, rounded, projecting beyond mouth; eye rather large, median, above level of mouth; gill-openings lateral, vertical or slightly inclined forward, 1.4 in head; nostrils large, posterior several times as large as anterior, both remote from eye, close together, near tip of snout; lateral line high, irregular in outline, roughly corresponding to dorsal outline.

First ten dorsal spines modified into anvil-shaped scutes, which are raised above the surface and are sharp at both ends. These are covered with flesh in the adult examples, and are not counted in the number given above for the dorsal and anal rays; first to fourth rays graduated, fourth longest, longer than head; remaining rays growing rapidly shorter to about the fifteenth, which is less than one-third the length of highest, and is about equal to the following ones; anal similar to dorsal, but of fewer rays and scutes; pectoral elongate, slender, reaching half-way to caudal, extending to dorsal notch; caudal deeply notched, the lower lobe usually the longer.

Color in spirits almost black above the lateral line, especially on top of caudal peduncle; below lateral line the sides become gradually lighter to about the median part, below which they are silvery, except in some specimens where the silver color is rubbed off; posterior part of opercle and margins of vertical fins black; pectoral pale or faint dusky. In most specimens the body and head are irregularly speckled with fine black points. A specimen from Port Arthur, noted by Jordan and Starks as *Stromateoides cinereus*, has D. 44; A. 42. One from Swatow has D. 44; A. 41. It is quite possible that the two forms *cinereus* and *echinogaster*, geminate species, the one northern, the other southern, may be found to intergrade.

Family EQUULIDÆ.

108. **Leiognathus argenteus** (Houttuyn). "Gira."

Fusan (*Equula nuchalis* of Schlegel). (No. 4256a.)

Family RACHYCENTRIDÆ.

109. **Rachycentron pondicerrianum** (Cuvier & Valenciennes). "Sugizame."

One large specimen seen in the museum at Fusan. It is not clear that this Asiatic species is distinct from *Rachycentron canadum* of the Atlantic.

Family CHEILODIPTERIDÆ.

110. **Amia lineata** (Schlegel).

Market of Fusan.

111. **Scombrops boöps** (Houttuyn).

Tsushima (Jouy).

Family PRIACANTHIDÆ.

112. **Priacanthus macracanthus** (Cuvier & Valenciennes).

Fusan (*Priacanthus benmebari* of Schlegel) ("Korea" 4511).

Family SERRANIDÆ.

113. **Lateolabrax japonicus** (Cuvier & Valenciennes). "Suzuki."

Fusan, abundant. ("Korea," Nos. 4479a, 4481a, 4552a–b, 4580.)

The dark spots on the sides are more distinct than usual in Japanese specimens. The species described from Pechili and Naukin as *Labrax lyiuy* by Basilewsky, *Ichthyographia Chinæ Borealis*, p. 219, is not identifiable unless it be by the Chinese name. It is a fish of the type of *Lateolabrax*, or *Epinephelus*, "blackish in life, striped and banded with dusky after death. Caudal entire; dorsal notched: it lives in all the rivers." Perhaps it is based on *Siniperca chuatsi*.

114. **Siniperca scherzeri** Steindachner. (Plate VI, fig. 1.)

This species is here described from two specimens respectively 160 and 90 mm. long, taken in the River Kan-ko near Fusan, Korea (No. 4174a). A larger specimen from Heijo has precisely the same color-markings (Suigen No. 4173). Head 2.6; depth 3.6; snout in head 3.5; eye 5.16; interorbital 6; depth caudal peduncle 3.6; maxillary 2.2. Dorsal XII, 13; anal III, 9; pores in lateral line about 100; series of scales along lateral line about 126, between lateral line and dorsal 23 to 25.

Body long, slender, compressed, deepest under fourth dorsal spine; head depressed in front, the upper profile descending abruptly at nape, and thence gradually in a straight line to tip of long, pointed snout. Lower jaw strongly

projecting; outline of back arched, descending abruptly under last three rays of soft dorsal; caudal peduncle deeper than long, tapering very little; ventral outline almost straight from snout to anal.

Spinous dorsal low, gently and evenly rounded from tip to tip; longest spine 3 in head; soft dorsal rounded, slightly higher than spinous dorsal, its base one-half that of the latter; caudal rounded; anal short, rounded, as high as soft dorsal; second spine longer and much stronger than longest dorsal spine; ventrals as long as pectorals, not nearly reaching vent; pectorals narrow. Maxillary reaching posterior margin of eye; preopercle with numerous small spines above, two larger ones at angle, and two on margin below; opercle with two broad, flat spines above; interorbital area slightly concave, smooth; body covered with very small ctenoid scales in uniform series; cheeks, opercles, and temporal region with small embedded scales; remainder of head naked; fins not scaled, except caudal base.

Color in spirits light brown, sides below lateral line with large round or ovate dark spots, separated by narrow, light, undulating streaks, forming rings around the spots. Above the lateral line the spots are smaller and more separated. Indistinct dark blotches are evident on back below middle of spinous dorsal, and below front of soft dorsal, and on caudal peduncle below last dorsal ray. Head above dark, with small, round, black spots; cheeks and opercles and all fins, except pectorals, spotted like upper part of sides; throat and belly white; spinous dorsal margined with black.

This species agrees fairly well with the description of *Siniperca scherzeri* Steindachner from the lower Yangtse River. It differs in the number of finrays (Dorsal XIII, 11 or 12 in *Siniperca scherzeri*), in the sharper and longer snout, and in the sharper coloration. It is probable that Steindachner's figure was taken from an older fish than the one here figured, but of the same species.

115. **Siniperca chuatsi** (Basilewsky).

(*Perca chuatsi* and *Perca chuantsi* Basilewsky, *Ichthyographia Chinæ Borealis*, p. 218? *Labrax lyiuy* Basilewsky, p. 219.)

Keumsan, Southern Korea (Schmidt). Not seen by us.

116. **Coreoperca herzi** (Herzenstein).

(*Coreoperca whitehcadi* Boulenger.)

Pung-tung (Herz) Not seen by us.

117. **Stereolepis ischinagi** (Hilgendorf). "Ishinagi."

A large specimen in the museum at Fusan.

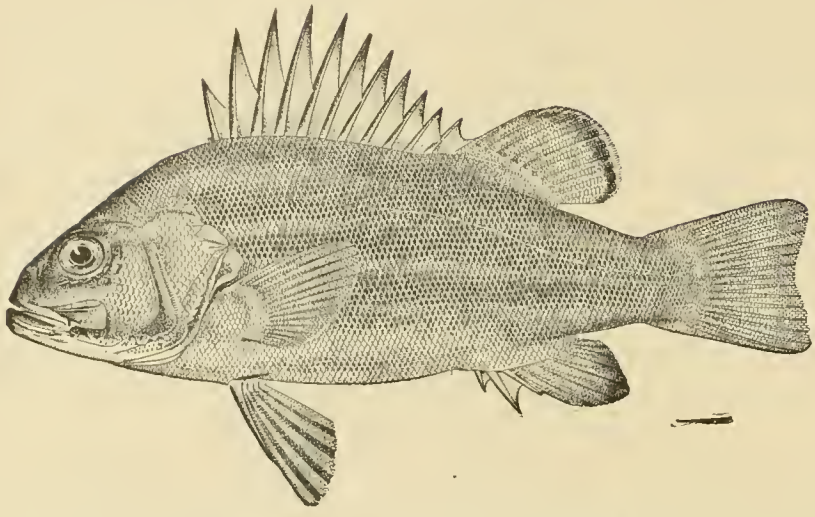


Fig. 22. *Stereolepis ischinagi* (Hilgendorf). (After Jordan & Richardson, Proc. U. S. N. M., Vol. XXXVII, p. 436.)

118. **Epinephelus tsirimenara** (Temminck & Schlegel). "Tsirimenara."
Seen in the Fusan museum.

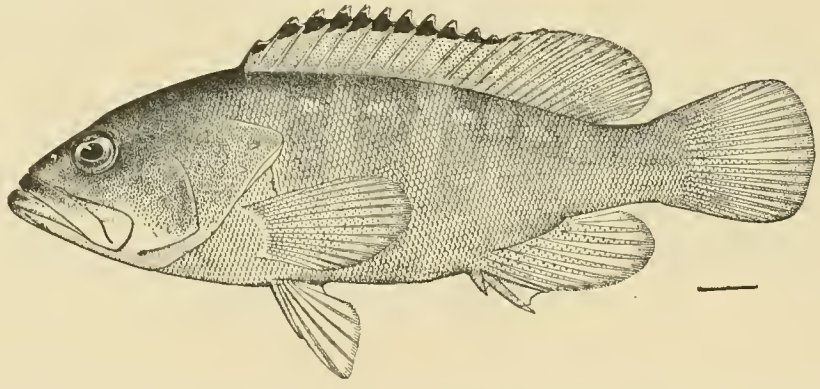


Fig. 23. *Epinephelus tsirimenara* (Temminck & Schlegel). (After Jordan & Richardson, Proc. U. S. N. M., Vol. XXXVII, p. 461.)

119. **Epinephelus septemfasciatus** (Thunberg).
Fusan market.

120. **Epinephelus awoara** (Temminck & Schlegel). "Aoara."
Fusan market.

121. **Epinephelus ionthas** sp. nov. (Plate VI, fig. 2.)
Type No. 4559, 14 inches, Fusan, Korea.
D. XI, 17; A. III, 8; head 2.33; depth 2.87; eye 5.75; maxillary 2.75;

interorbital 6; scales about 15, 95. Dorsal outline more convex than ventral; body deep, greatest depth through axil of pectoral; profile of head arched above, rather high at nape, nearly straight from tip of snout to nape; lower jaw strongly projecting, entering dorsal profile; back high under spinous and most of soft dorsal, descending rather abruptly to deep, short, caudal peduncle, which is two-thirds as long as deep; caudal rounded; both dorsals high, with a shallow notch between; first four dorsal spines graduated, fourth highest, equal to longest soft ray, which is 2.75 in head; origin of dorsal above margin of preoperele; origin of ventrals well behind axil of pectoral; pectoral rounded, broad, reaching tips of ventrals, but not nearly to vent; mouth large, slightly oblique; maxillary reaching well behind eye; teeth on sides of lower jaw in two rows; body and head, except mandibles and maxillaries scaled; scales on anterior part of head, and ventral part of head and body very small; dorsal and anal unscaled.

Color in spirits light; sides thickly covered with round dark spots (orange-red in life), about one-fourth the diameter of eye, separated by narrow light interspaces; spots becoming more or less confluent and indistinct on middle and lower part of sides; head lighter, the spots more scattered; cheeks dark with round light spots; mandibles and maxillaries uniformly light in color; below the sixth and seventh dorsal spines is an indistinct dark blotch, followed under the last four spines by one which is larger and more conspicuous. No spots below soft dorsal; spinous dorsal light with a narrow dark margin; soft dorsal spotted like body; caudal dusky, black-edged; anal with black margin and a black bar one-third from base; ventrals tipped with black; pectorals pale.

Described from the type, which is fourteen inches in total length, and was taken at Fusan, Korea. It is No. 4559 in the Catalog of the Carnegie Museum. Numerous other specimens were seen in the market.

The species is allied to *Epinephelus akaara*, but is distinguished by the color and the deeper body.

Family HÆMULIDÆ.

122. **Pomadasis hasta** (Bloch).

Fusan (Jouy).

123. **Hapalogenys nigripinnis** (Temminck & Schlegel).

Fusan ("Korea" 4502a).

124. **Hapalogenys mucronatus** (Eydoux & Souleyet).

Chinnampo (No. 4113a), Fusan. ("Korea" 4507a–b, 4522a–e.) Called

"Banzaidai," apparently a vernacular name. It was transferred by Schlegel to *Banjos banjos*, to which it may possibly properly belong.

125. **Plectorhynchus cinctus** (Temminck & Schlegel).
Fusan ("Korea" 4537a–b).

Family SPARIDÆ.

126. **Pagrosomus major** Temminck & Schlegel. "Madai," "Tai," "Akadai."
Pagrus arthurius Jordan and Starks.
Port Arthur (Abbott); Fusan, Chemulpo ("Korea" 4540a–i).

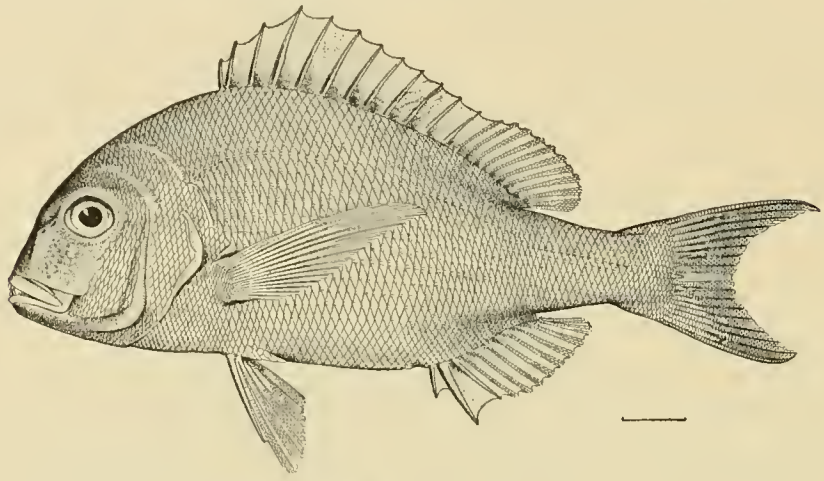


Fig. 24. *Pagrosomus major* Temminck & Schlegel. (After Jordan & Starks, Proc. U. S. N. M., Vol. XXXI, p. 518.)

Abundant; one of the most important Japanese food-fishes; equally abundant in Korea. The specimen from Port Arthur, named *Pagrus arthurius*, is an ordinary "red tai," with the third dorsal spine injured.

127. **Evynnis cardinalis** (Lacépède). "Kodai."
Fusan (Jouy).

128. **Taius tumifrons** (Temminck & Schlegel).
Abundant in Tsushima Straits, in deep water.

129. **Sparus macrocephalus** (Basilewsky). "Kurodai."
(*Chrysophrys swinhonis* Günther.)
Fusan, common ("Korea" 4496a). This species has watery flesh, very much inferior to that of the red tai, or "akadai" (*Pagrosomus major*). It is evident that this is the species poorly figured and poorly described by Basi-

lewsky as *Pagrus macrocephalus*. This name must replace that of *Sparus swinhonis*, adopted from Günther, by Jordan and Thompson. In the numbering

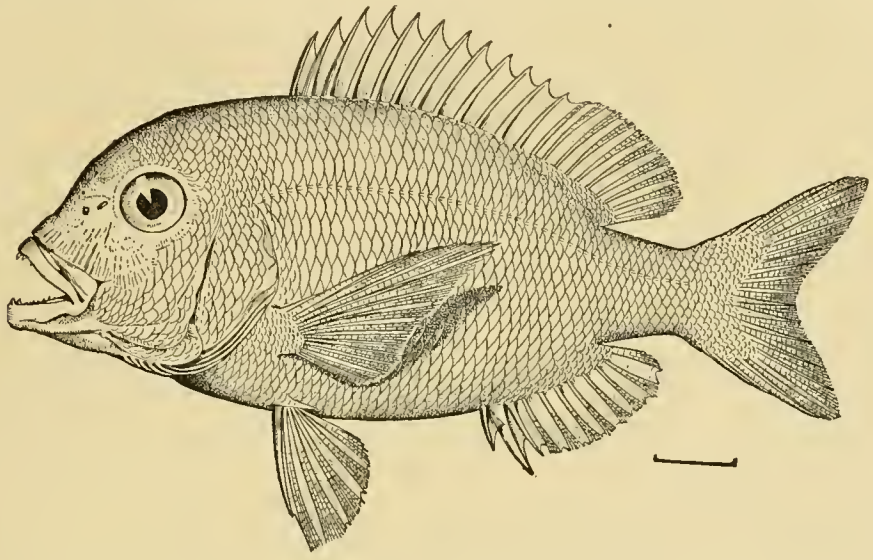


Fig. 25. *Taius tumifrons* (Temminck & Schlegel). (After Jordan & Thompson, Proc. U. S. N. M., Vol. XLI, p. 572.)

of his plates, Basilewsky has transposed this species and his *Sciæna tenlo* (= *Sciæna albiflora*).

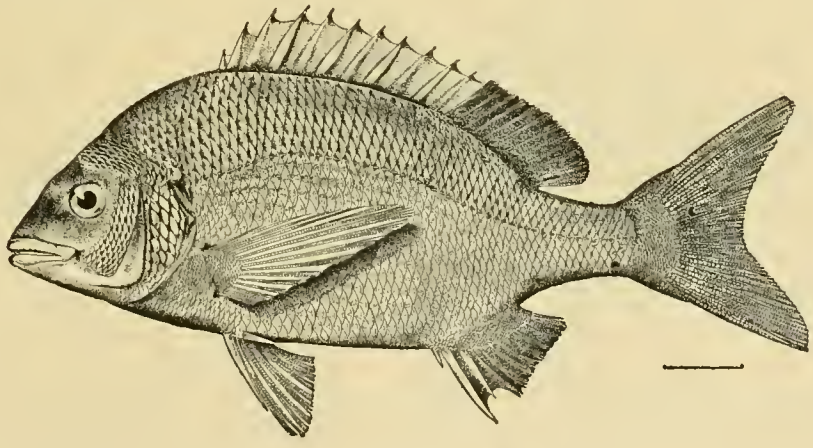


Fig. 26. *Sparus macrocephalus* (Basilewsky). (After Jordan & Thompson, Proc. U. S. N. M., Vol. XLI, p. 587.)

Family SCIÆNIDÆ.

130. **Sciæna japonica** (Temminck & Schlegel). (Plate VII, fig. 1.) "Nibe."
? *Sciæna miiuy* Basilewsky, *Ichthyographia Chinæ Borealis*, p. 22, Pechili.
Chinnampo (No. 4356a and 4368a), Fusan ("Korea" 4493a–d, 4581); a

common food-fish, but not highly valued, being reputed to be rather coarse. It reaches a length of about four feet.

The species has not been recorded since the time of Temminck and Schlegel, who knew it only from a drawing by Bürger, a drawing perfectly recognizable. The existence of the species has been questioned by Steindachner, and by Jordan and Thompson.

The following are the field notes of Dr. Jordan (Seoul Market). Dark dusty gray in life. Dorsal and caudal black; a faint, dark, axillary blotch. Preopercle with long, slender, flexible points. Body slender; caudal rhombic; scales loose. Outer teeth in both jaws equally enlarged; head pointed; jaws subequal; maxillary 2.66 in head. Pectoral long, 2 in head; anal spines very small. Gill-rakers 10 + 12, including rudiments; all of them short and thick; dorsal scaleless. Dorsal X, I, 29; anal II, 7; scales 75. All the dorsal spines low, the third highest.

131. **Sciæna albiflora** (Richardson). "Akaguchi," "Kuchi."

Sciæna tenlo Basilewsky, *Ichthyographia Chinæ Borealis*, p. 220. Gulf of Pechili.

Port Arthur (Abbott); Fusan, Chinnampo (No. 4357a, 4372a) ("Korea" 4519a).

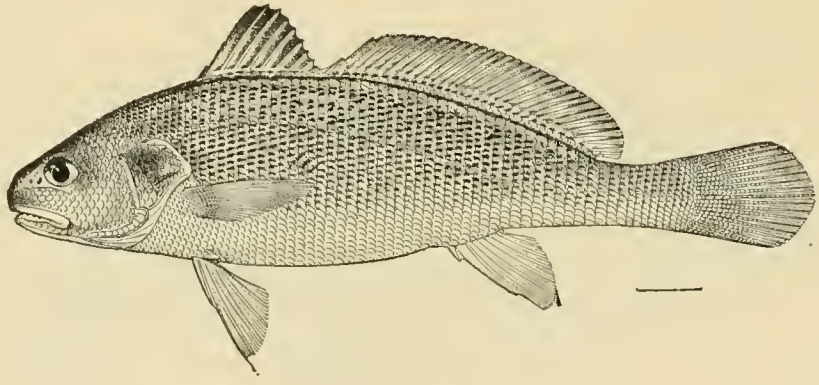


Fig. 27. *Sciæna albiflora* (Richardson). (After Jordan and Thompson, Proc. U. S. N. M., Vol. XXXIX, p. 250.)

Next to the red tai (*Pagrosomus major*) this is the commonest fish at Fusan, being salted in great numbers. In life it is lustrous brassy, or coppery in color, hence called "akaguchi" or red croaker. It is fairly well figured and very poorly described by Basilewsky as *Sciæna tenlo*.

The slight differences separating the Japanese species *Sciæna mitsukurii* from this species seem to hold in our specimens.

132. **Sciæna schlegeli** Bleeker. "Kuchi."

Chinnampo (No. 4259a), Fusan market.

This may be the *Sciæna chanchua* or yellow fish ("piscis flavus pictus") of Basilewsky, *Ichthyographia Chinæ Borealis*, p. 221. The description is however very inadequate, and might refer to *Sciæna manchurica*.

133. **Sciæna iharæ** sp. nov. (Plate VII, fig. 2.) "Guchi."

Type No. 4371, 300 mm. Fusan, Korea.

Head 3; depth 3.25; eye 6 in head; 1.66 in snout; interorbital 3.5 in head; maxillary 2.33. Dorsal X, 29; anal II, 7; scales 8, 50, 12 or 13 (above ventrals); gill-rakers 7 + 9, comparatively short and stout; longest one .4 diameter of eye.

Body compressed, its width 2 in depth, elongate, deepest through base of pectorals; lower outline only slightly curved; head rather long; snout not abruptly blunted, its outline continuing to the even curve of profile of head above; lower jaw included; maxillary reaching posterior fourth of eye; teeth in two rows, the outer conical, sharp, and slender, the inner minute; angular bone of lower jaw notched posteriorly and projecting mesially, on this projection a slender, deciduous spine, which is hinged below and depressible into a groove at base; preopercle unarmed, its margin finely notched; opercle with two, flat, flexible points. Scales large, ctenoid, firm, covering body and head, except lips; no scales on vertical fins, but soft dorsal and anal sheathed with a row at base.

Pectorals long, narrow, pointed, 1.4 in head; ventrals inserted below axil of pectoral, reaching about two-thirds distance to vent; spinous dorsal rather short and high, its base 1.8 in soft dorsal; fourth spine 2.75 in head; soft dorsal uniform, about .8 height of first dorsal; caudal rounded; anal short, rounded, higher than spinous dorsal.

Color silvery below, brownish above; dorsal edged with dusky; a conspicuous black blotch on opercle; centers of scales dark, forming indistinct longitudinal bands, irregularly broken above and below.

Described from the type 300 mm. long, collected by Dr. Jordan at Fusan, Korea (No. 4371a). It is named for Mr. B. Ihara, the Commissioner of Fisheries in Chosen.

This species resembles *Sciæna schlegeli* (Bleeker), but has firmer flesh, with non-deciduous scales, has a longer, less blunt snout, a much smaller eye, (6 in head instead of 4), and has 29 instead of 25 to 27 rays in the soft dorsal. Basilewsky's *Sciæna arcuata, Ichthyographia Chinæ Borealis*, p. 221, salted for the market of Peking and sent up from southern China, is some species of this type. It cannot be *Sciæna iharæ*, as it is said to have 11 or 12 dorsal spines.

In the paper on the Sciænidæ of Japan, by Jordan and Thompson, the name *Sciæna argentata* is accepted from Houttuyn for the species called *Sciæna bleekeri* by Steindachner. On fuller comparison we are obliged to reject Houttuyn's trivial description as inadequate and unidentifiable. The Japanese species from Tokyo, in question, however, cannot be *Sciæna bleekeri*, which is an Indian species. It must apparently receive the substitute name, suggested by Dr. Döderlein, of *Sciæna yeddoënsis*.

134. **Sciæna manchurica** Jordan & Thompson.
Port Arthur (Abbott).

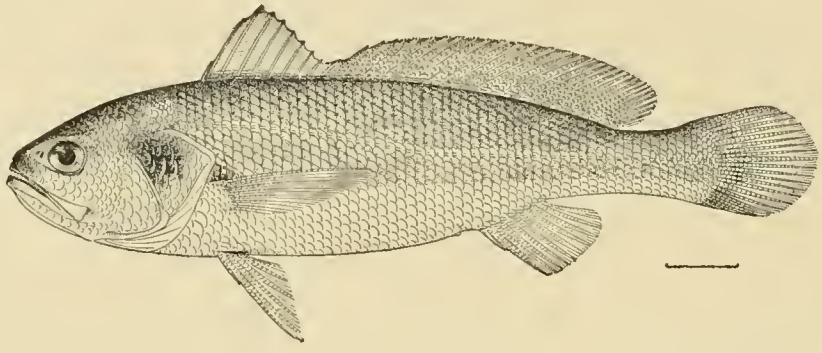


Fig. 28. *Sciæna manchurica* Jordan & Thompson. (Proc. U. S. N. M., Vol. XXXIX, p. 256.)

135. **Laramichthys rathbunæ** Jordan & Starks.
Chinnampo (No. 4141a); Fusan (Jouy).

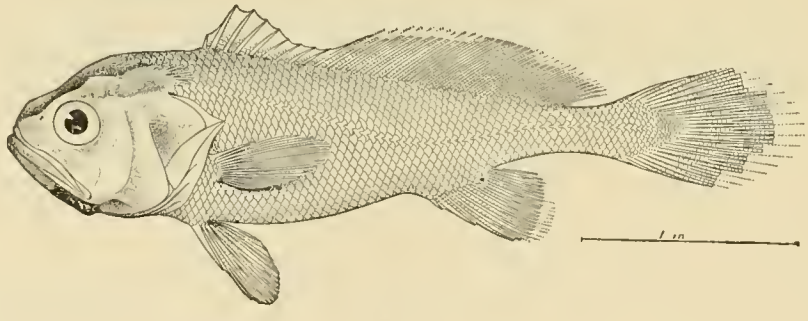


Fig. 29. *Laramichthys rathbunæ* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 204.)

This specimen from Chinnampo, in much better condition than the original type, agrees with it in all essential respects.

136. **Collichthys lucidus** (Richardson).
(? *Sciæna meygun* Basilewsky, *Ichthyographia Chinæ Borealis*, p. 222; Southern Sea of China.)

Sciæna meygun Basilewsky, said to be brought to Peking, salted, from the sea to the south, is certainly a species of *Collichthys*, but no specific characters are given. The dorsal rays in *C. lucidus* are 33.

Korea (Bernadou).

137. **Collichthys fragilis** Jordan & Seale.

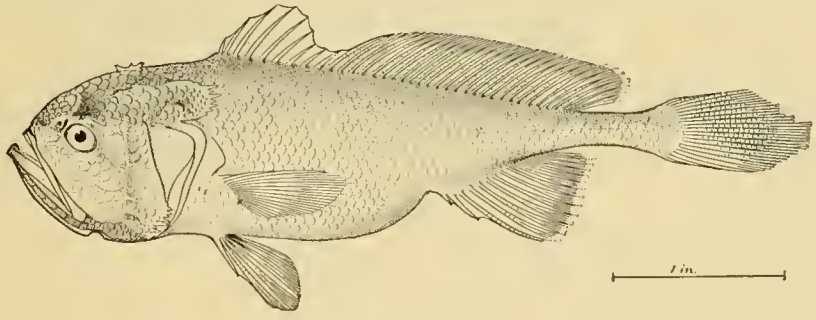


FIG. 30. *Collichthys fragilis* Jordan & Seale. (Proc. U. S. N. M., Vol. XXIX, p. 523.)

Port Arthur (Abbott); Fusan market. Locally very abundant. Dorsal rays 27.

138. **Collichthys niveatus** Jordan & Starks.

Chinnampo (No. 4577); Port Arthur (Abbott). Dorsal rays 24.

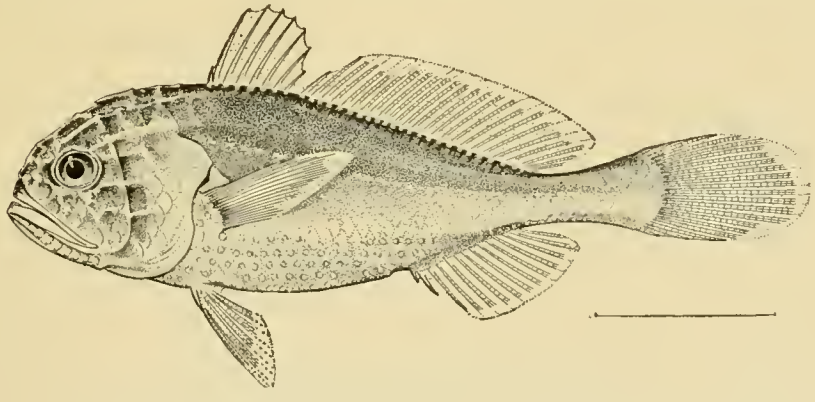


FIG. 31. *Collichthys niveatus* Jordan & Starks. (Proc. U. S. N. M., Vol. XXXI, p. 519.)

Family MULLIDÆ.

139. **Upeneoides bensasi** (Temminck & Schlegel).

"Himeji." Jinsen (No. 4320a–b).

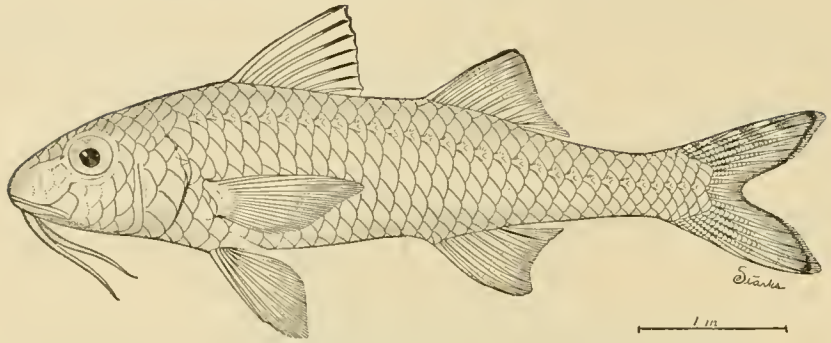


Fig. 32. *Upeneoides bensasi* (Temminck & Schlegel). (After Snyder, Proc. U. S. N. M., Vol. XXXII, p. 98.)

Family POLYNEMIDÆ.

140. **Polydactylus agonasi** Jordan & McGregor.

Seen in Fusan museum.

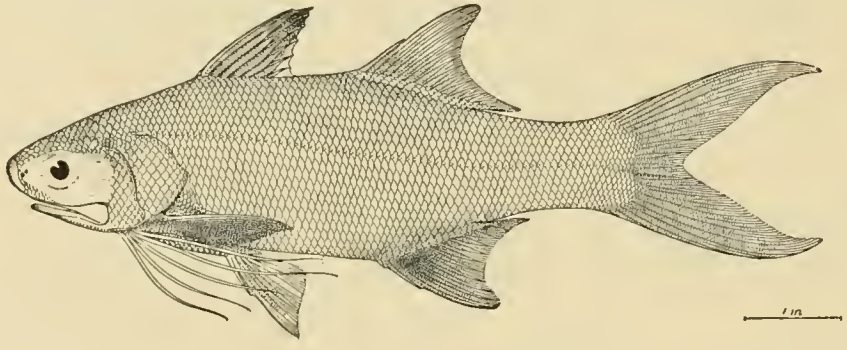


Fig. 33. *Polydactylus agonasi* Jordan & McGregor. (Proc. U. S. N. M., Vol. XXX, p. 815.)

141. **Polydactylus prionostomus** (Basilewsky).

Osteoglossum prionostoma Basilewsky, *Ichthyographia Chinæ Borealis*, p. 211; Gulf of Pechili.

This species is not known to us. It is evidently a species of *Polydactylus*, but it is described as having six free pectoral filaments ("pectoralium priores radii sex longi"). The only species of *Polydactylus* yet known from these waters is *Polydactylus agonasi* with five free filaments. The fins in *Polydactylus prionostomus* are said to be pale. In the Chinese species with six filaments, *P. xanthonemus* and *P. sectarius*, the pectorals are black.

Family OPLEGNATHIDÆ.

142. **Oplegnathus fasciatus** (Temminck & Schlegel).

Fusan ("Korea" 4504a).

Family CIRRHITIDÆ.

143. **Goniistius zonatus** (Cuvier & Valenciennes).
Fusan ("Korea" 4483a).

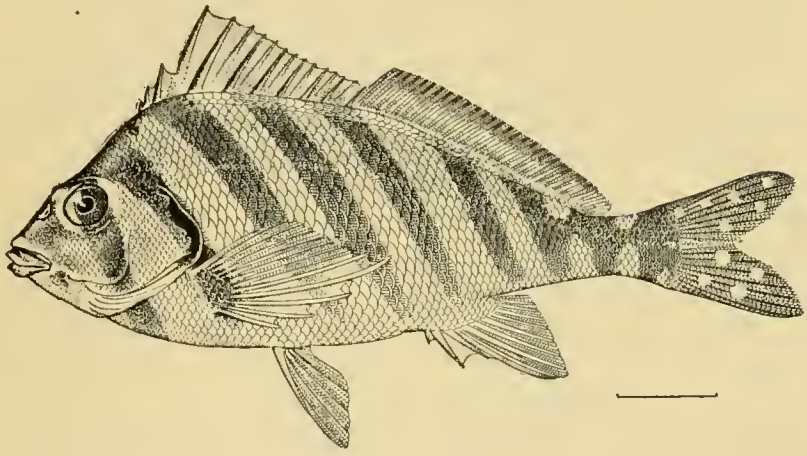


Fig. 34. *Goniistius zonatus* (Cuv. & Val.). (After Jordan & Herre, Proc. U. S. N. M., Vol. XXXIII, p. 164.)

Family SILLAGINIDÆ.

144. **Sillago sihama** Forskal. "Kisu."
Chinnampo, Fusan (No. 4163a, 4321a); common.

Specimens of this species show great variation in the depth of the body, attenuation of the head and snout, and height of the spinous dorsal. All seem to belong to one species, however, and to be identical with others from Japan, Swatow, Hong Kong, Formosa, and the Philippines.

Family PTEROPSARIDÆ.

145. **Neopercis sexfasciata** (Temminck & Schlegel). "Toragisu."
Fusan ("Korea" 4525a–b).

146. **Neopercis snyderi** Jordan & Starks.
Korea (Jouy).

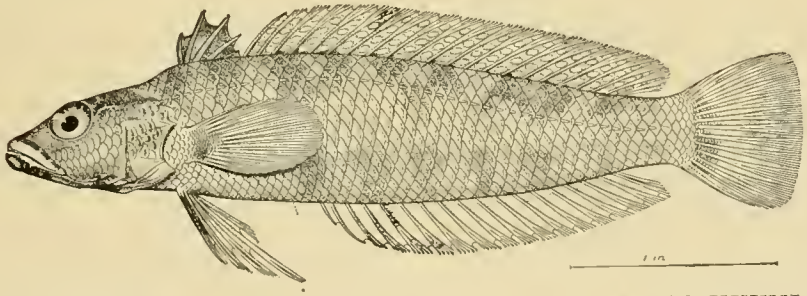


Fig. 35. *Neopercis snyderi* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVIII, p. 211.)

Family URANOSCOPIDÆ.

147. **Uranoscopus japonicus** Houttuyn.
Fusan ("Korea" 4551a–b).

Family ANABANTIDÆ.

148. **Polyacanthus opercularis** (Linnæus). (Korean name "Pottrupungo.")
Suigen (No. 4122a–i); Fusan (Jouy).

149. **Macropodus viridi-auratus** Lacépède.
Seoul (Steindachner).

Family OPHICEPHALIDÆ.

150. **Ophicephalus argus** Cantor. "Eso."

(No. 4523a.) Very abundant in the Han River at Seoul, and daily brought alive into the markets. The species was described by Cantor from Chusan Island off Shanghai. *Ophicephalus pekinensis* Basilewsky is apparently the same.

Family EMBIOTOCIDÆ.

151. **Ditrema temmincki** Bleeker.
Fusan, common.

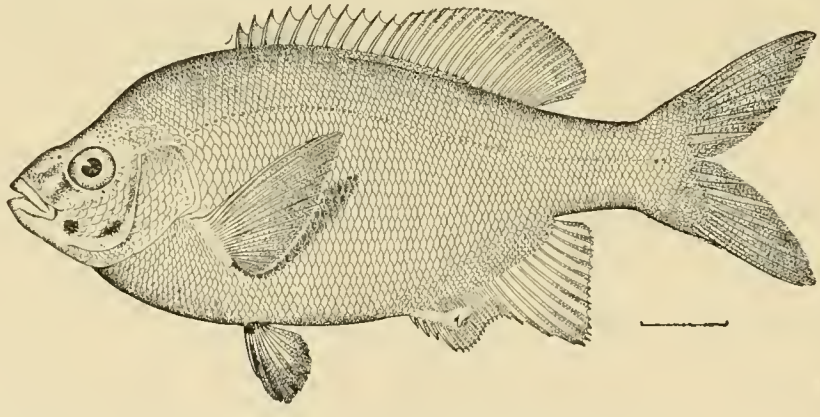


Fig. 36. *Ditrema temmincki* Bleeker. (After Jordan & Sindo, Proc. U. S. N. M., Vol. XXIV, p. 358.)

152. **Neoditrema ransonneti** (Steindachner).
Tsushima (Jouy).

153. **Chromis notatus** Temminck & Schlegel.
Tsushima (Jouy).

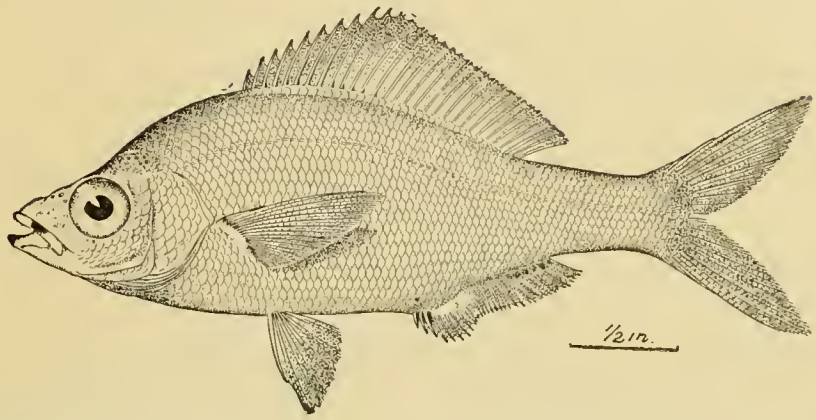


Fig. 37. *Neoditrema ransonneti* (Steindachner). (After Jordan & Sindo, Proc. U. S. N. M., Vol. XXIV, p. 356.)

Family LABRIDÆ.

154. **Semicossyphus reticulatus** Cuvier & Valenciennes.
Fusan, specimens large and small (No. 5413a–b).

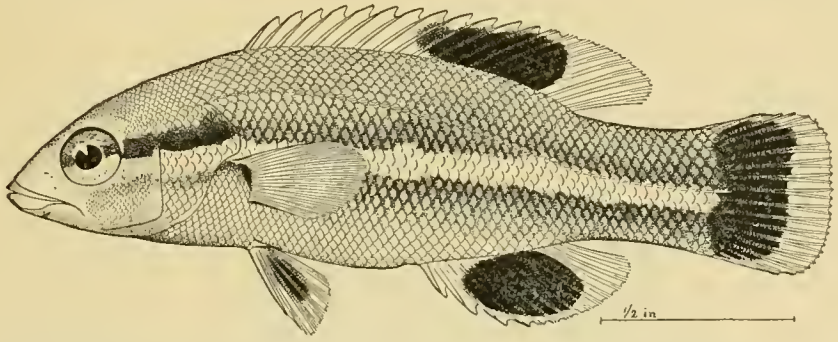


Fig. 38. *Semicossyphus reticulatus* Cuv. & Val. (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 622.)

155. **Pseudolabrus japonicus** (Houttuyn).
Fusan, common; Tsushima (Jouy) ("Korea" 5447a).

156. **Halichœres bleekeri** Steindachner & Döderlein. "Aobera."
Fusan (No. 4312).

157. **Halichœres pœcilopterus** (Temminck & Schlegel). "Akabera."
Three males and one female; the former corresponding to the "*pyrrhogrammus*" of Temminck and Schlegel. Such large sexual difference as occurs in this species is rare among the *Labridæ*.
Fusan (No. 4542a).

Family ZEIDÆ.

158. **Zeus japonica** Temminck & Schlegel. "Matodai."
Fusan, Straits of Tsushima ("Korea" 4482a).

Family TEUTHIDÆ.

159. **Teuthis fuscescens** (Houttuyn). "Aigo."
Fusan (No. 4204a–j).

Under the present rules of the International Congress of Zoologists, *Teuthis* Linnæus should apparently replace *Siganus* Forskål. The genus *Teuthis* of Linnæus included a species of *Hepatus* (*hepatus* Linnæus) (*Acanthurus* Forskål) and one *Siganus* (*javus*). It was first restricted to *Teuthis javus* Linnæus and its allies by Cuvier in 1817, an arrangement followed by Cuvier and Valenciennes, Cantor, and Günther. This adjustment must apparently stand, although the original *Teuthis* of Linnæus (1866) has the same content as the earlier *Hepatus* of Gronow (1765).

Family MONACANTHIDÆ.

160. **Stephanolepis japonicus** (Tylesius).
Fusan (Jouy).

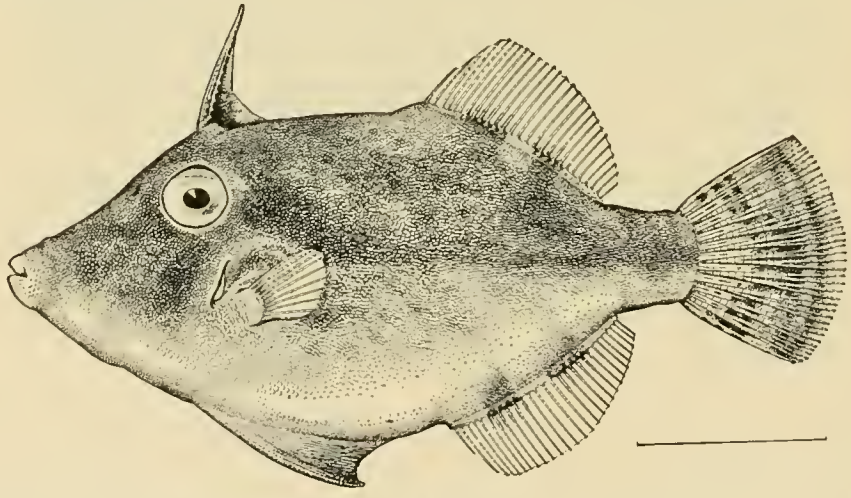


Fig. 39. *Stephanolepis japonicus* (Tylesius). (After Jordan & Fowler, Proc. U. S. N. M., Vol. XXV, p. 266.)

161. **Stephanolepis cirrhifer** (Temminck & Schlegel). "Kawahagi."
Fusan, common (No. 4508a–b).

162. **Pseudomonacanthus unicornu** (Basilewsky). "Unadzura-hayi," "Mahagi."

Balistes unicornu Basilewsky, *Ichthyographia Chinæ Borealis*, 1855, p. 263; Shan Dun province.

Monacanthus modestus Günther, *Annals & Magazine Nat. Hist.*, 1877, p. 446.

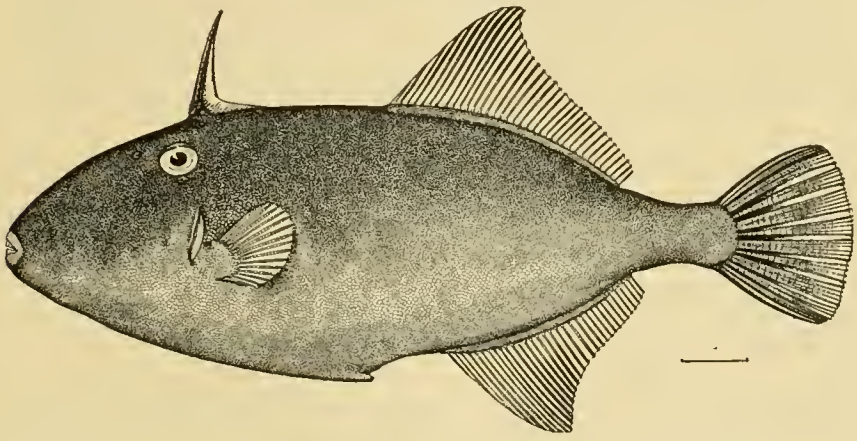


FIG. 40. *Pseudomonacanthus unicornu* (Basilewsky). (After Jordan & Fowler, Proc. U. S. N. M., Vol. XXV, p. 269.)

Fusan; a common market-fish ("Korea" 4486a–c).

There seems no doubt that Basilewsky's description belongs to this particular species, although it contains very little which is not of general application to these fishes. This species is common in the waters of western Korea, and in its measurements it agrees with *B. unicornu*.

163. **Alutera monoceros** (Osbeck).

Fusan ("Korea" 4469a).

Family TETRAODONTIDÆ.

164. **Spheroides rubripes** (Temminck & Schlegel). "Torafugu."

Chinnampo (No. 4374a), Fusan, common ("Korea" 4535a–c).

A large specimen has the prickles on back and belly obsolete.

165. **Spheroides xanthopterus** Temminck & Schlegel.

Chinnampo (No. 4377a); back unspotted.

166. **Spheroides pardalis** (Temminck & Schlegel). "Fugu."

Heijo, Fusan, Chinnampo (No. 4370a); abundant. (Suigen, No. 4576a–b "Korea" 4512a–f.)

167. **Spheroides borealis** Jordan & Snyder.
Chinnampo (No. 4261a).

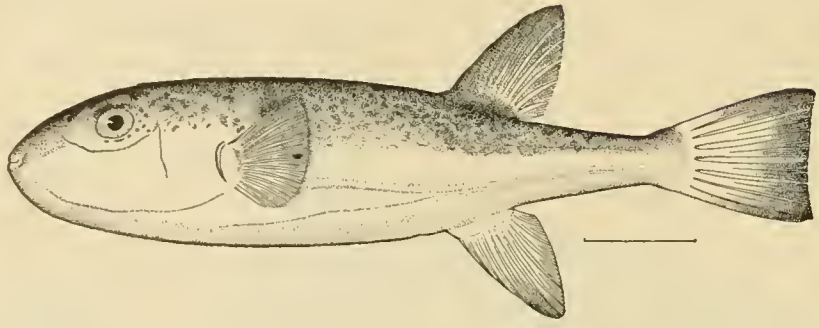


Fig. 41. *Spheroides borealis* Jordan & Snyder. (Proc. U. S. N. M., Vol. XXIV, p. 245.)

168. **Spheroides vermicularis** (Temminck & Schlegel).
Chinnampo (No. 4111a).

169. **Spheroides basilewskianus** (Basilewsky). (Plate VIII, fig. 1.)
Tetraodon basilewskianus Basilewsky, *Ichthyographia Chinæ Borealis*, p. 262; Sea off Peking.
Chinnampo (No. 4573).

A large specimen agrees with the scanty account of *Tetraodon basilewskianus* and differs from the closely related Japanese species *Spheroides alboplumbeus* in the total absence of white spots. It may be provisionally accepted as a valid species.

The following description is from two examples 10 inches long, taken at Chinnampo, Korea:

D. 13; A. 13; head 3; depth 3; eye 8; snout 2.4; interorbital 2; least depth of caudal peduncle 3.2 in head; width of body 3.33 in length. Back and belly with small, stout prickles; caudal truncate; no lateral body fold; body rather stout, elongate, greatest depth through gill-opening; ventral outline very convex, dorsal less so; head broad; snout blunt; interorbital area slightly convex, broad; caudal peduncle depressed, tapering, semi-conical; nostrils papilliform, elevated, as near tip of snout as eye; eye small, elevated, entirely above level of pectoral base; gill-openings vertical, equal to pectoral base, inner flap evident; mouth terminal, broad, teeth large, cutting edges concave; anterior portion of teeth slightly produced, bluntly pointed.

Dorsal high, fifth ray longest, 1.5 in head; posterior rays gradually shortened to near last, then abruptly shortened; distance from insertion of dorsal to tip of snout two and one-half times that from base of caudal, the latter equal-

ling distance from posterior edge of mouth to gill-opening; anal opposite and similar to dorsal; pectoral broad, short, almost truncate; upper rays slightly longer, equal to snout in length.

Color in spirits uniform dusky ashen above upper level of gill-opening, darker on back; an ocellated spot considerably larger than eye near tip of pectoral; area at base of dorsal dark, but without distinct spot; under parts white. Dorsal, anal, and caudal tipped with blackish; pectorals dusky brown; sides and back without any indication of stripes or spots, except the pectoral spots.

This species resembles *Spheroides alboplumbeus* of Japan and Southern China, but differs in size of eye, interorbital width, etc., and also in color, *S. alboplumbeus* being covered above with conspicuous white spots.

Family TRICHODONTIDÆ.

170. **Arctoscopus japonicus** Steindachner.

Chinnampo (No. 4109a–c). Several fine specimens were obtained agreeing perfectly with Steindachner's original description and figure.

The figure published by Jordan and Evermann (Fishes of North and Middle America) from deep water off Iturup Island represents a deeper fish, perhaps specifically distinct.

Family HEXAGRAMMIDÆ.

171. **Pleurogrammus azonus** sp. nov. (Plate VIII, fig. 2.)

Type No. 4558, 14 inches, Chinnampo.

D. XXI, 29; A. 27; scales 20, 180; pores 163; depth 4.5; head 3.6; eye 5.66; maxillary 2.87; snout 3; interorbital 3.33; depth of caudal peduncle 5 in head; body long, rather slender, greatest depth through base of ventrals; dorsal and ventral outlines similar; head rather stout; nape not high; dorsal profile evenly curved; snout blunt; lower jaw included; maxillary reaching to below anterior margin of eye; interorbital area convex; eye moderate, high, but not entering dorsal profile. Dorsal inserted above posterior margin of preopercle, continuous and almost uniform in height throughout; sixth spine 2.6 in head; anal similar to soft dorsal; pectorals large, rounded; fifth to eighth rays longest; ventrals inserted below sixth dorsal spine, reaching not quite to tips of pectorals, slightly over half the distance to anal; caudal large, emarginate, its basal portion trenchant above and below; caudal peduncle stout, almost as broad as deep; gill-rakers 5 + 14, wide apart; mouth rather large, oblique; no teeth on vomer

or palatines; teeth in jaws in bands, outer row enlarged, canine-like, inner rows becoming obsolete on sides; gill-membranes united, free from the isthmus, the opening extending forward slightly below; body, cheeks and upper parts of head with small ctenoid scales, not extending on vertical fins.

First lateral line separated from dorsal by four rows of scales (five anteriorly), each approaching its fellow in front of dorsal and behind dorsal, but in neither case uniting with it. The origin is on top of the head slightly behind eye, the apex is on base of caudal peduncle. Second lateral line runs parallel to first for length of dorsal, then descends abruptly to middle of caudal peduncle and thence in a straight line to base of caudal. Third lateral line extends from a point on a level with the sixteenth pectoral ray and above the middle of the ventrals, to above the last anal ray. Fourth lateral line runs from isthmus along edge of ventrals, to above first anal ray. Fifth extends along base of anal, uniting with its fellow between tips of inner ventral rays, running thence to isthmus. In addition to these there is a short line lying just above the fourth and reaching from above middle of ventrals to opposite vent. On one side of our specimen this unites for a short distance with the fourth, on the other it is free. The first and second lines are separated by fifteen scales anteriorly; the third and fifth by ten scales opposite insertion of anal.

Fig. 42. *Hexagrammus aburaco* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVI, p. 1008.)

Color dusky above, lighter below; fins all dusky; dorsal with black cloudings; caudal lobes black-tipped; no trace of the black cross-bands characteristic of *P. monopterygius*.

Described from the type which is fourteen inches in total length, taken at Chinnampo, Korea. It is No. 4558 in the Catalog of the Carnegie Museum.

This species differs from *Pleurogrammus monopterygius* in the slenderer body,

larger number of fin-rays, larger scales, the different lateral lines, and the absence of dark cross-bars on the body.

172. **Agrammus agrammus** (Temminck & Schlegel).
Fusan (No. 4487a).

173. **Hexagrammus otakii** Jordan & Snyder. "Aburame."
Chinnampo (No. 4365a), and Fusan, common ("Korea" 4489a).

174. **Hexagrammus aburaco** Jordan & Starks. "Ainame."
Fusan (No. 4500a). One specimen of this rare form. It may possibly be a variant of *Hexagrammos otakii*, rather than a distinct species.

Family SCORPÆNIDÆ.

175. **Sebastodes schlegeli** Hilgendorf.
Chinnampo (No. 4162a; No. 4381a), Fusan; Gensan (Schmidt); Tsushima (Jouy) ("Korea" 4531a).

This species is everywhere common in Northern Japan and Korea. The early name, *Sparus fuscescens* of Houttuyn, adopted by Jordan and Starks, is, as we believe, not identifiable. We therefore take a later name, *schlegeli*, apparently not open to doubt.

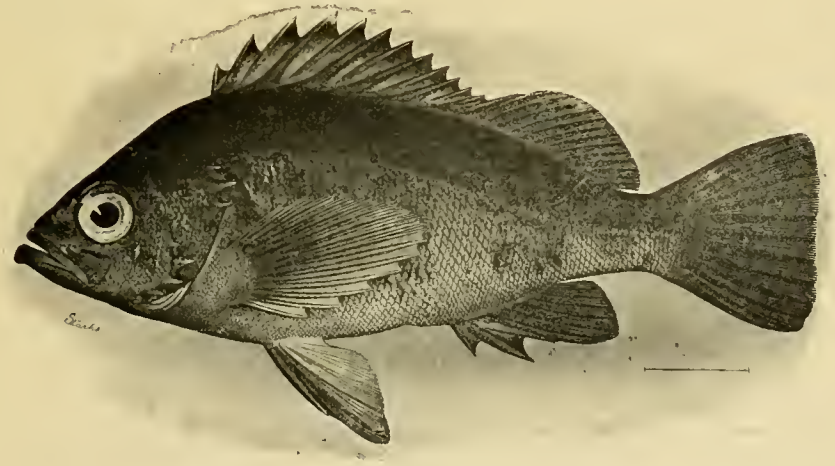


Fig. 43. *Sebastodes güntheri* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVII, p. 102.)

176. **Sebastodes güntheri** Jordan & Starks.
Chinnampo (No. 4106a).

177. **Sebastodes ijimæ** sp. nov. (Plate IX, fig. 1.)
Type No. 4172, 160 mm. long. Fusan.

Head 2.5; depth 2.73; eye 4 in head; interorbital 5; snout 4.25; maxillary 2; width of maxillary in eye 1.4; depth of caudal peduncle in head 3.16. D. XIII, 13; A. III, 5; pores in lateral line 33; series of scales along lateral line about 62. Body rather short, high, and compressed; greatest depth through base of pectoral; back sloping gently behind and rather abruptly in front of this; profile almost straight from nape to snout; head nearly as deep as long; maxillary reaching well behind eye, posteriorly quite broad; suborbital narrow, less than half as broad as maxillary, bearing two blunt processes anteriorly; preopercle with five short processes, the lowest small; upper angle of opercle with two sharp processes; lower margin with two smaller ones opposite middle of preopercular spine; humeral spine present, short, flat, sharp; occiput and interorbital scaly, almost flat, the armature moderate; preorbital and postorbital spines form a continuous ridge above eye; parietal and tympanic spines small, not elevated; nasal spines prominent.

Spinous dorsal moderately high, rounded; fourth and fifth spines longest, 1.8 in head; notch between dorsals obtuse, the membrane of first dorsal confluent with that of second for one-third its height; soft dorsal truncate, as high as third spine of first dorsal; last three rays only are graduated; caudal bluntly rounded; anal short, high, truncate, its rays as long as fourth dorsal spine; second spine equal to third in length, and much stouter; ventrals inserted behind pectoral base, tips almost reaching anal; pectoral broad, rounded, its lower rays thickened.

Body and head, except snout, preorbital and jaws, covered with strongly ctenoid scales, those of occiput, interorbital and temporal regions abruptly smaller; soft fins scaled at base with minute, numerous scales; peritoneum white; gill-rakers 7 + 18, rather slender, compressed, longest about .4 diameter of eye.

Color dusky, lighter below; fins all dark, tipped with black, except the lower half of pectoral which has a broad, white margin; snout and top of head almost black.

Described from the type, 160 mm. long, taken at Fusan, Korea, by Dr. Jordan (No. 4172a).

This species is near *Sebastodes schlegeli* (Hilgendorf) (Plate X, fig. 1), but is readily distinguished from this by the small number of pores (33 instead of 46) in the lateral line, and by other less conspicuous characters. It is named for Professor Isao Ijima, of the Imperial University of Tokyo, to whom we are indebted for many favors.

178. **Sebastodes inermis** (Cuvier & Valenciennes). "Mebaru."
Fusan (No. 4530a–d).

179. **Sebastodes taczanowskii** Steindachner.
Gensan (Schmidt).

180. **Sebastodes trivitattus** Hilgendorf.
Chinnampo (No. 4363a), Chemulpo.

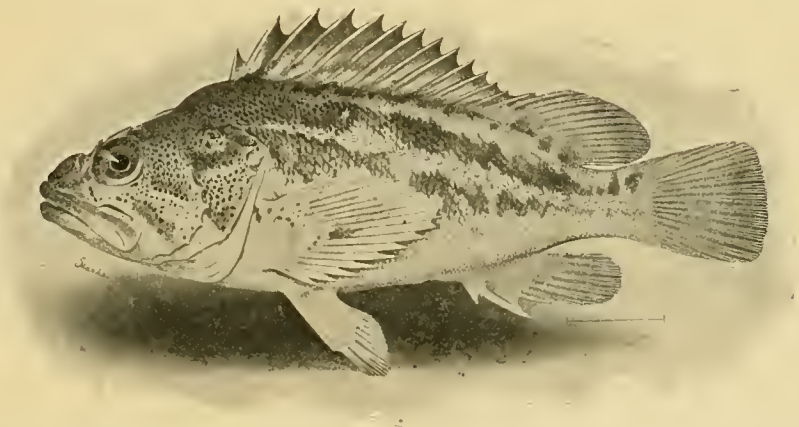


Fig. 44. *Sebastodes trivittatus* Hilgendorf. (After Jordan & Starks, Proc. U. S. N. M., Vol. XXVII, p. 115.)

181. **Sebastichthys elegans** (Steindachner & Döderlein).
Fusan (No. 4546a), common: common also across the channel at Shimonoseki.

Fig. 45. *Sebastichthys elegans* (Steindachner). (After Jordan & Starks, Proc. U. S. N. M., Vol. XXVII, p. 119.)

182. **Sebastichthys vulpes** (Steindachner & Döderlein).
Fusan (No. 4538a).

183. **Sebastichthys mitsukurii** (Cramer).
Fusan (No. 4499a).

184. **Sebastichthys pachycephalus** (Temminck & Schlegel).
Fusan (No. 4516a).

185. **Sebastiscus marmoratus** (Cuvier & Valenciennes).
Fusan, common (No. 4554a–c); Tsushima (Jouy).

186. **Inimicus japonicus** (Cuvier & Valenciennes). "Kasago."
Fusan, common (No. 4509a–c).

187. **Paracentropogon rubripinnis** (Temminck & Schlegel).
Fusan (Jouy).

Family COTTIDÆ.

188. **Cottus pœcilopus** Heckel.
Pung-tung (Herz).

189. **Trachydermus fasciatus** Heckel.
Trachydermus ansatus (Richardson).
Chemulpo (Jouy).

Fig. 46. *Trachydermus fasciatus* Heckel. (After Jordan & Starks, Proc. U. S. N. M., Vol. XXVII, p. 263.)

We think that the name *fasciatus* should be adopted for this species, as it is quite unlikely that Heckel's type really came from the Philippines. It lives in torrential waters in Korea and Southern Japan, and is recorded from China.

190. **Gymnocanthus intermedius** (Temminck & Schlegel).
Fusan. One specimen.

This specimen deviates from the usual form of this species. The eye is 4.5 instead of 3.5 in head; the armature of the preopercle is poorly developed, the antler-like process having only two horns and not reaching the edge of the preopercle.

191. **Furcina ishikawæ** Jordan & Starks.
Fusan (Jouy).

Fig. 47. *Furcina ishikawæ* Jordan & Starks. (Proc. U. S. N. M., Vol. XXVII, p. 304.)

192. **Bero elegans** (Steindachner).
Chemulpo.

Fig. 48. *Bero elegans* (Steindachner). (After Jordan & Starks, Proc. U. S. N. M., Vol. XXVII, p. 318.)

193. **Pseudoblennius percoides** (Richardson).
Fusan (No. 4550a–b); Tsushima (Jouy).

194. **Pseudoblennius marmoratus** Steindachner.
Tsushima (Jouy).

195. **Hemitripterus villosus** (Pallas).
Chinnampo (No. 4375a); two fine large specimens.

Family AGONIDÆ.

196. **Tilesina gibbosa** Schmidt.
Broughton Bay, Korea (Schmidt).

197. **Podothecus gilberti** Collett.
Cape Pestschnizoff, Korea (Schmidt).

198. **Podothecus thompsoni** Jordan & Gilbert.
Cape Pestschnizoff, Korea.

199. **Anoplagonus inermis** (Günther).
Cape Pestschnizoff.

Family PLATYCEPHALIDÆ.

200. **Platycephalus indicus** (Gmelin). "Kochi."
Chinnampo (No. 4382a), Fusan, common ("Korea" 4545a).

201. **Thysanophrys crocodilus** (Tilesius).
Fusan (No. 4521a).

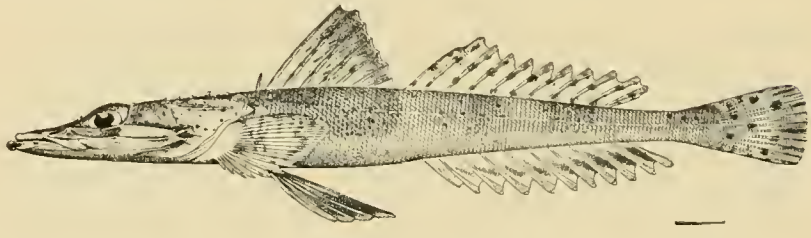


Fig. 49. *Thysanophrys crocodilus* (Tilesius). (After Jordan & Richardson, Proc. U. S. N. M., Vol. XXXIII, p. 639.)

Family BEMBRIDÆ.

202. **Parabembras curtus** (Temminck & Schlegel).
Fusan (No. 4548a).

Family CYCLOGASTERIDÆ.

203. **Cyclogaster tanakæ** Gilbert & Burke.
Fusan.

Family TRIGLIDÆ.

204. **Cheilidonichthys kumu** (Lesson & Garnot). "Hobo."
Fusan, common (No. 4532a).

205. **Lepidotrigla guntheri** Hilgendorf.
Fusan (Jouy).

206. **Lepidotrigla microptera** (Günther).
Port Arthur (Abbott).

The Japanese form (*Lepidotrigla strauchii* Steindachner) is apparently different from this Chinese species.

Family GOBIIDÆ.

207. **Periophthalmus cantonensis** (Osbeck).
Fusan, on the mud flats (No. 4245a).

208. **Apocryptes chinensis** Osbeck.
Korea (Jouy).

This genus, usually called *Boleophthalmus*, is based on the original type of the genus *Apocryptes* of Osbeck. The name was diverted to a genus of another group by Cuvier.

209. **Odontobutis obscurus** (Temminck & Schlegel). (Korean name "Kuguri.")
Suigen.

210. **Ctenogobius bernadoui** (Jordan & Starks).
Korea (Jouy).

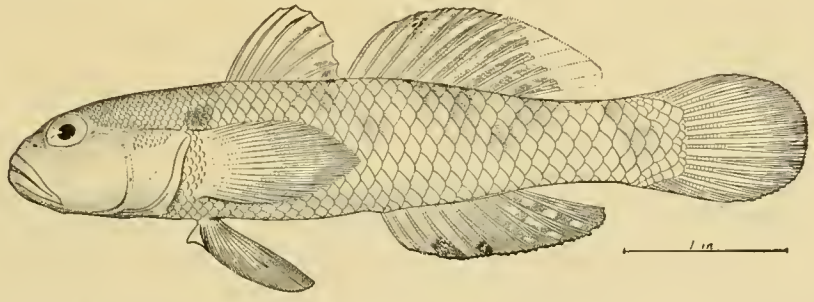


FIG. 50. *Ctenogobius bernadoui* (Jordan & Starks). (Proc. U. S. N. M., Vol. XXVIII, p. 207.)

211. **Ctenogobius similis** Gill. (Plate X, fig. 3.)
Tsushima (Jouy).

212. **Ctenogobius hadropterus** (Jordan & Snyder). (Korean "Sangukuguki.")
Suigen; numerous small specimens which seem to be identical with this Japanese species (No. 4116a–d).

213. **Aboma tsushimæ** Jordan & Fowler.
Tsushima (Jouy).

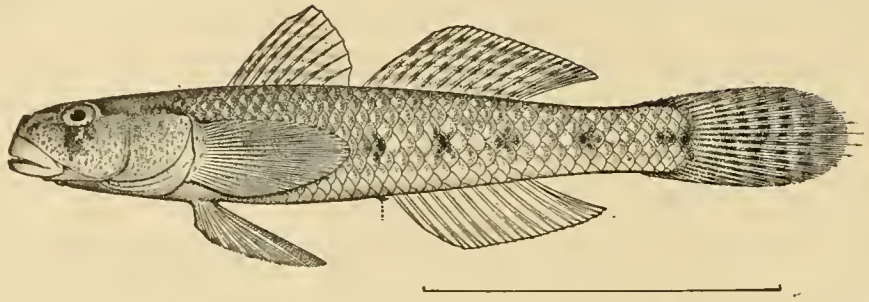


Fig. 51. *Aboma tsushimæ* Jordan & Fowler. (Proc. U. S. N. M., Vol. XXV, p. 575.)

214. **Chænogobius macrognathus** (Bleeker).
Gensan (Jouy).

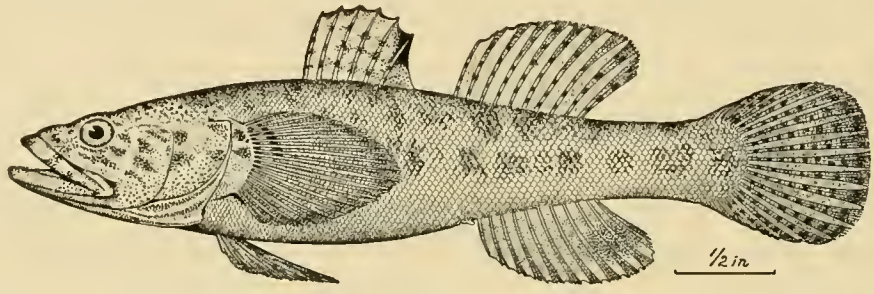


Fig. 52. *Chænogobius macrognathus* (Bleeker). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 77.)

215. **Chlœa sarchynnis** Jordan & Snyder.
Gensan (Jouy).

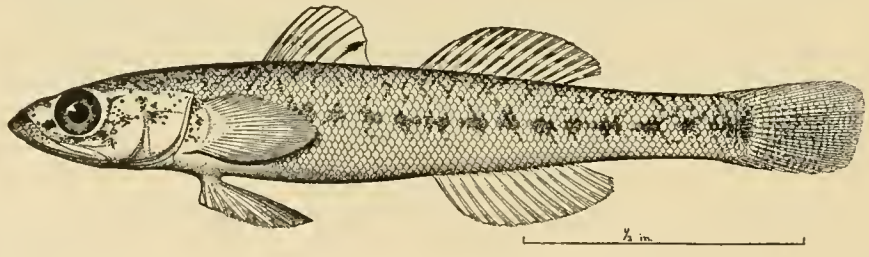


Fig. 53. *Chlœa sarchynnis* Jordan & Snyder. (Proc. U. S. N. M., Vol. XXIV, p. 83.)

216. **Pterogobius elapoides** (Günther).
Korea (Jouy).

Pterogobius daimio Jordan & Snyder seems to be the southern representative of this handsome species.

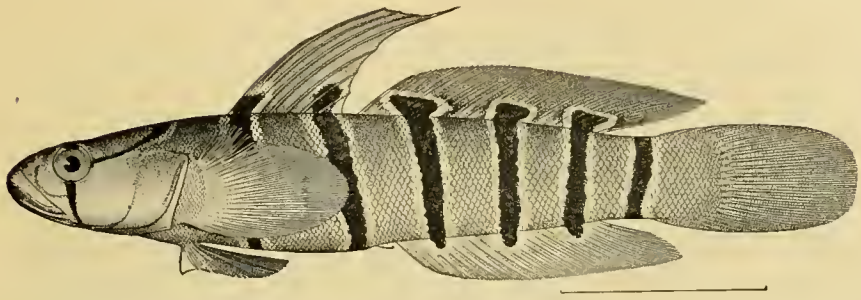


FIG. 54. *Pterogobius elapoides* (Günther). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 92.)

217. **Chasmichthys gulosus** (Sauvage). (Plate X, fig. 2).
Chasmias misakius Jordan & Snyder.
Fusan; Gensan (Jouy).

218. **Chasmichthys dolichognathus** (Hilgendorf).
Korea (Jouy).

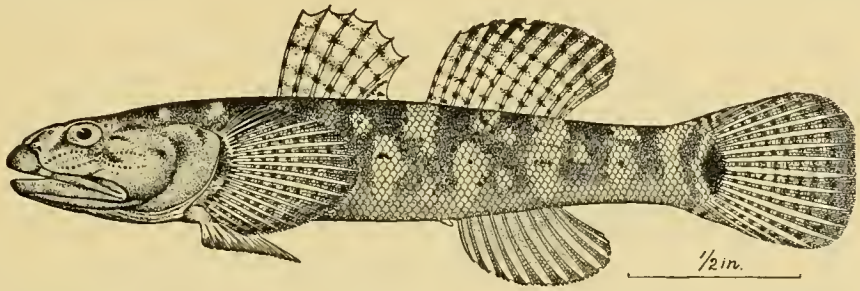


FIG. 55. *Chasmichthys dolichognathus* (Hilgendorf). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 85.)

219. **Acanthogobius flavimanus** (Temminck & Schlegel). "Haze."
Fusan (No. 4534a–c); excessively abundant; Tsushima (Jouy).

220. **Acanthogobius hasta** (Temminck & Schlegel).
Chemulpo (Jouy).

221. **Acanthogobius stigmathonus** (Richardson).
Fusan (Jouy).

222. **Chæturichthys stigmatius** (Richardson).
Tsushima (Jouy).

223. **Tridentiger obscurus** (Temminck & Schlegel).
Gensan; Chemulpo (Jouy).

224. **Tridentiger bifasciatus** Steindachner.
Gensan; Fusan (Jouy).

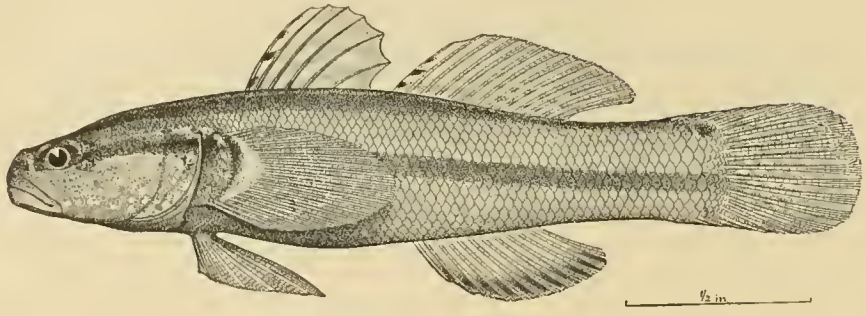


Fig. 56. *Tridentiger bifasciatus* Steindachner. (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXIV, p. 118.)

225. **Ranulina fimbriidens** Jordan & Starks.
Port Arthur (Abbott).

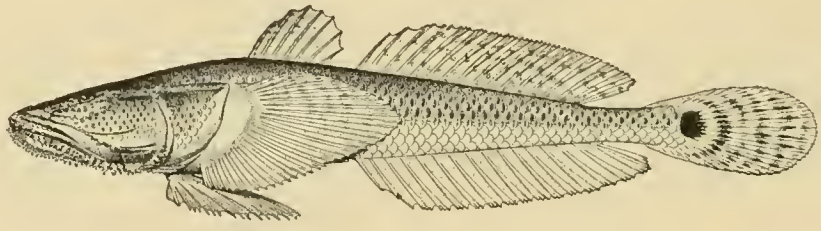


Fig. 57. *Ranulina fimbriidens* Jordan & Starks. (Proc. U. S. N. M., Vol. XXXI, p. 523.)

226. **Tænioides abbotti** Jordan & Starks.
Port Arthur (Abbott).

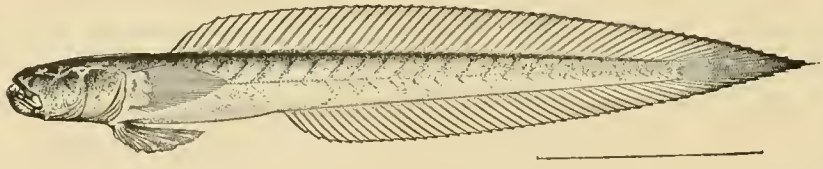


Fig. 58. *Tænioides abbotti* Jordan & Starks. (Proc. U. S. N. M., Vol. XXXI, p. 524.)

Family CALLIONYMIDÆ.

227. **Callionymus valenciennesi** (Temminck & Schlegel).
Market of Fusan.

FIG. 59. *Callionymus valenciennesi* Schlegel. (After Jordan & Fowler, Proc. U. S. N. M., Vol. XXV, p. 951.)

Family PLEURONECTIDÆ.

228. **Paralichthys coreanicus** Schmidt. "Hirame."
Fusan (No. 4480a), Port Arthur, Gensan (Schmidt).

229. **Paralichthys percocephalus** (Basilewsky).
Off Peking.
This seems to be the same as *Paralichthys swinhonis* Günther, from Chifu. We have not seen it.

230. **Verasper variegatus** (Temminck & Schlegel). "Hoshikarei."
Fusan (No. 4533a–d), Port Arthur.

231. **Verasper moseri** Jordan & Gilbert.
Chinnampo (No. 4229a).

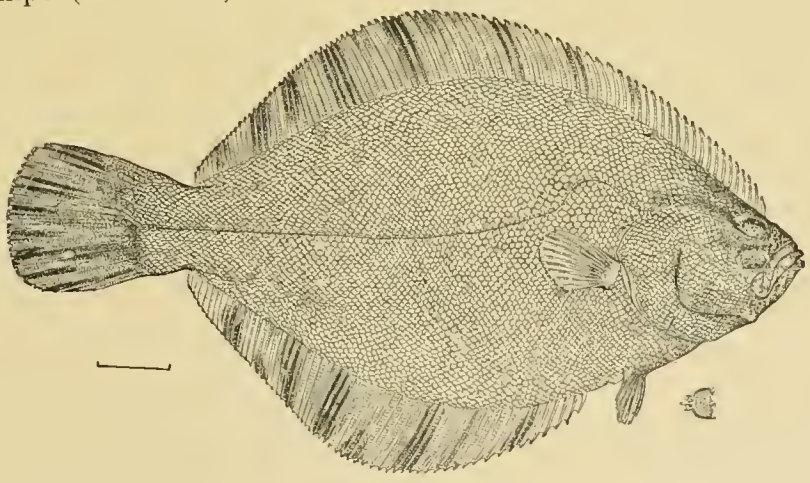


FIG. 60. *Verasper moseri* Jordan & Gilbert. (After Jordan & Starks, Proc. U. S. N. M., Vol. XXXI, p. 186.)

This specimen has the rather high arch of the lateral line of *Verasper moseri*, but the large spots on dorsal and anal approach *Verasper variegatus*. It may be that the two intergrade, *Verasper moseri* being the northern form.

232. **Protopsetta herzensteini** (Schmidt).
Port Arthur (Abbott).

233. **Platichthys stellatus** (Pallas).
Gensan (Jouy).

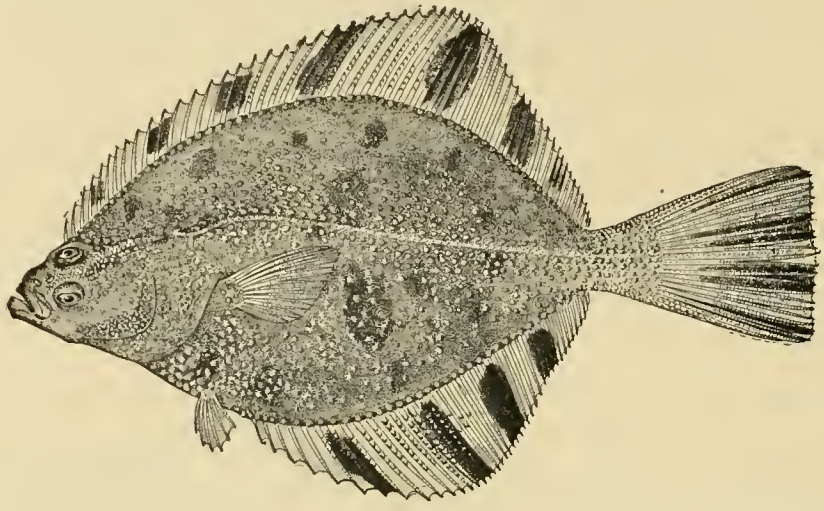


Fig. 61. *Platichthys stellatus* (Pallas). (After Jordan & Starks, Proc. U. S. N. M., Vol. XXXI, p. 219.)

234. **Kareius bicoloratus** (Basilewsky).
(*Pleuronectes scutifer* Steindachner.)
Gensan (Jouy); Gulf of Pechili (Basilewsky); Port Arthur.

235. **Pleuronichthys cornutus** Temminck & Schlegel. "Meitakarei."
Fusan (No. 4506a–b).

236. **Liopsetta obscura** (Herzenstein).
Chemulpo (Schmidt); Gensan.

237. **Lepidopsetta bilineata** (Ayres).
Gensan.

238. **Limanda yokahamæ** Günther.
Fusan, Port Arthur ("Korea" 4517a).

Family SOLEIDÆ.

239. **Zebrias fasciatus** (Basilewsky). (Plate IX, fig. 2.)
Solea fasciata Basilewsky, *Ichthyographia Chinæ Borealis*, p. 261. Shan-Dun.
Fusan (Basilewsky).

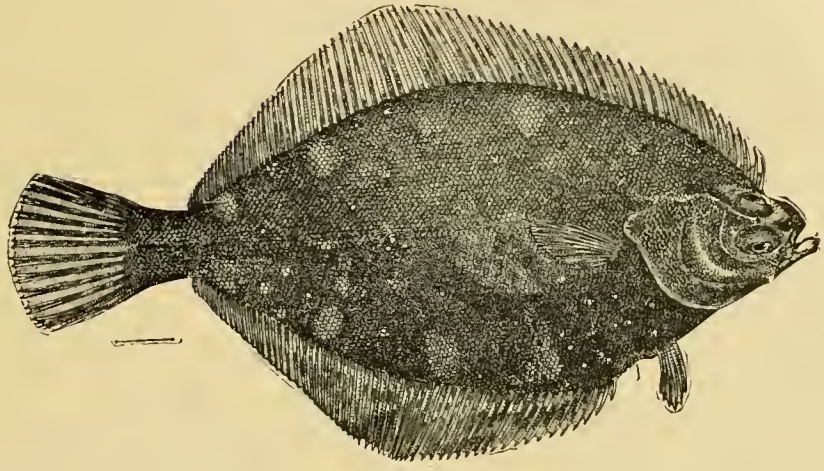


FIG. 62. *Lepidopsetta bilineata* (Ayres). (After Jordan & Starks, Proc. U. S. N. M., Vol. XXXI, p. 202.)

The following description is from two specimens (No. 4514), the larger 29 cm. in length, taken by Dr. Jordan in the market at Fusan, where the species is common:

Eyes and color on the right side; D. 83; A. 74; caudal 16; scales from above gill-opening to base of caudal 118, above lateral line 35, below 42, series across head between upper edge of gill-opening and upper eye 28, between gill-opening and lower eye 24. Body long, ovate-lanceolate; seventeen dark cross bars on eyed side behind head, all but the first arranged in pairs; head with six cross bands, also in pairs; eye small, 6–7 in head, nearly twice interorbital space. Measurements in hundredths of total length: Head 15; depth 39; snout 4; lower eye to gill opening 9.7. Mouth small, cleft to anterior third of lower eye, which is almost in contact with it; upper eye slightly in advance of lower; no rostral hook; scales all roughly ctenoid, those of anterior part of blind side provided with fleshy flaps, or papillæ; fins scaled nearly to tips.

Ground-color pale, broken on eyed side with dark cross-bands as mentioned above; dorsal and anal with continuations of markings of body on eyed side, margined with black.

The cross-bands of this species are typically arranged in pairs, of which there are 12 between snout and caudal. Some of them, however, may be so joined as to make a pair look like a single band, especially near the pectoral fin.

The larger number of fin-rays and scales distinguish this species from any other of the genus. In appearance it is not distinguishable from *Zebrias zebrinus* of Southern Japan and China. The two are clearly "geminate species," the northern form being *Zebrias fasciatus*, with an increased number of fin-rays.

240. **Areliscus hollandi** sp. nov. (Plate IX, fig. 3.) "Ushinoshita."

Type No. 4369, 365 mm. Fusan, Korea.

Eyes and color on left side; three lateral lines on the eyed side, one on the blind; no fringe on lips; gill-rakers obsolete; D. 128; A. 100; caudal 8 to 10; scales in lateral line from above gill-opening to base of caudal 112; scales above middle of upper lateral line 7; between upper and median lines 18–19, between median and lower 19–20, below lower line 7–8; series between lower eye and gill-opening 21–22.

Body very long, slender, lanceolate; mouth small; no rostral hook (in our specimen); maxillary extending beyond lower eye; villiform teeth on blind side of jaws; eye small, 12 in head, equal to interorbital space; nostrils two, one between eyes, the other near mouth before lower eye; scales of both sides strongly ctenoid, except on the upper part of head on blind side, where they are embedded; fins not scaled.

Measurements in hundredths of body length: Head 18; depth 26; snout from upper eye 6.5; lower eye to gill-opening 10.

Color white on blind side, dull olive-brown on eyed side; no markings; fins similar to body color; posteriorly dark on eyed side.

Described from the type 365 mm. long, taken at Fusan, Korea, by Dr. Jordan. It is named for Dr. William J. Holland. It is No. 4369a in the Catalog of the Carnegie Museum.

The accompanying figure is not absolutely accurate in respect to dorsal and anal fin-rays, which are correctly counted above.

241. **Areliscus abbreviatus** (Gray). "Shitabarame."

Description of a specimen 360 mm. long from Fusan, Korea. (No. 4358a.) Color on left side; D. 114; A. 90; caudal 10; scales from above gill-opening to caudal 118; above middle of upper lateral line 9 or 10; between upper and middle lines 22; between median and lower line 20; below lower line 9 or 10; about 24 series of scales between lower eye and upper part of gill-opening. Body very long, lanceolate; posterior two-thirds tapering gradually; lateral lines three on eyed side; fins not scaled; mouth small, rostral hook well developed, ending in advance of lower eye; eyes small, 13 in head, equal to interorbital, upper slightly in advance of lower; nostrils prominent, one between eyes, the other near cleft of mouth in front of lower eye; maxillary extending beyond lower eye; no fringe or cirrhi on lips. Measurements in hundredths of body length: Head 23; depth 27; snout from upper eye 8; lower eye to gill-opening 12. Scales of eyed side roughly ctenoid, those of blind side cycloid or

very slightly ctenoid, small, entirely embedded in skin on upper part of head, somewhat imbedded on rest of blind side.

Color white on blind side, uniform dull olive-brown on eyed side; no markings.

This species may be readily distinguished from *Areliscus semilævis* by the smaller number of scales, and from *A. purpureomaculatus* by the smaller number of fin-rays. The species called *Achirus plagusia* by Basilewsky (*Ichthyographia Chinæ Borealis*, p. 245), from the Gulf of Pechili, is some *Areliscus* or *Cynoglossus*, but the species cannot be determined.

242. **Areliscus rhomaleus** Jordan & Starks.
Port Arthur (Abbott).

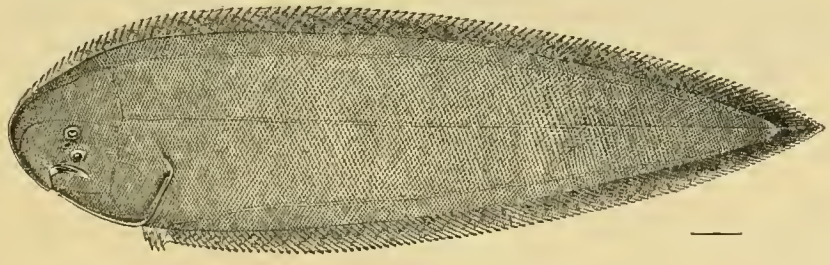


Fig. 63. *Areliscus rhomaleus* Jordan & Starks. (Proc. U. S. N. M., Vol. XXI, p. 526.)

Family BLENNIIDÆ.

243. **Zoarchias aculeatus** (Basilewsky).
Ophidium aculeatum Basilewsky, *Ichthyographia Chinæ Borealis*, p. 248. Sea off Peking.

The name *Ophidium aculeatum* is applied by Basilewsky to some blennoid fish without ventrals, with concealed scales, with 32 stiff, short, dorsal spines, with the dorsal and anal united around the tail, the mouth large, without barbels, and cleft to the eyes. The body is gray with black spots and points, the lateral line straight, spotted; length of fish 8 inches. This species must be one of the Eulophiine blennies and near the genus *Zoarchias*. *Zoarchias veneficus* has 28 dorsal spines.

244. **Dictyosoma temmincki** Bleeker.
Tsushima (Jouy).

245. **Enedrias nebulosus** (Temminck & Schlegel).
(Native name "Ginbo.")
Tsushima (Jouy); Fusan, common (No. 4244a); Gensan.

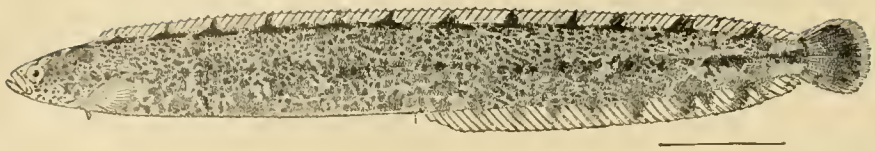


Fig. 64. *Enedrias nebulosus* (Schlegel). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXV, p. 469.)

246. **Pholis taczanowskii** (Steindachner).
Gensan, Fusan (Jouy).

247. **Dinogunnellus grigorjewi** (Herzenstein).
Chinnampo, a fine specimen, No. 4379a.

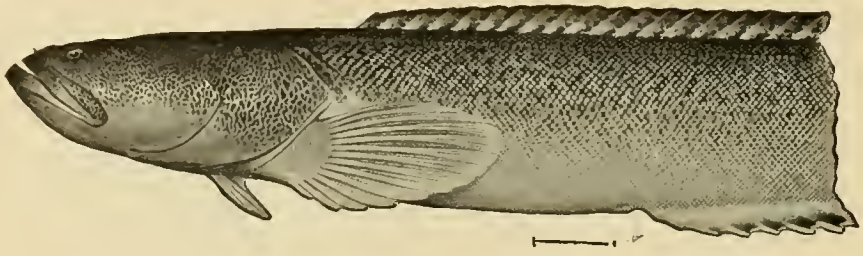


Fig. 65. *Dinogunnellus grigorjewi* (Herzenstein). (After Jordan & Snyder, Proc. U. S. N. M., Vol. XXV, p. 497.)

Family LYCODIDÆ.

248. **Enchelyopus gilli** (Jordan & Starks).
Fusan (Jouy).

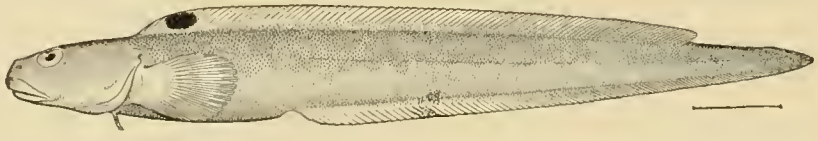


Fig. 66. *Enchelyopus gilli* (Jordan & Starks). (Proc. U. S. N. M., Vol. XXVIII, p. 212.)

Family GADIDÆ.

249. **Pollachius brandti** (Hilgendorf).
(Native name "Suketo-dara.")
Fusan (No. 4367a), one specimen filled with eggs. A soft-bodied fish, apparently from deep water. Head 4 in length; depth 6.5; eye 4 in head; snout 3.33; D. 12, 14, 19; A. 19, 19.

250. **Eleginus navaga** (Koelreuter).
Chemulpo (Schmidt); Chinnampo (No. 4200a and 4188a–b).

251. **Gadus macrocephalus** Tilesius.
Chinnampo (No. 4378a); Port Arthur (Abbott).

Family LOPHIIDÆ.

253. **Lophius litulon** (Jordan & Sindo).
Seen in the Fusan Museum.

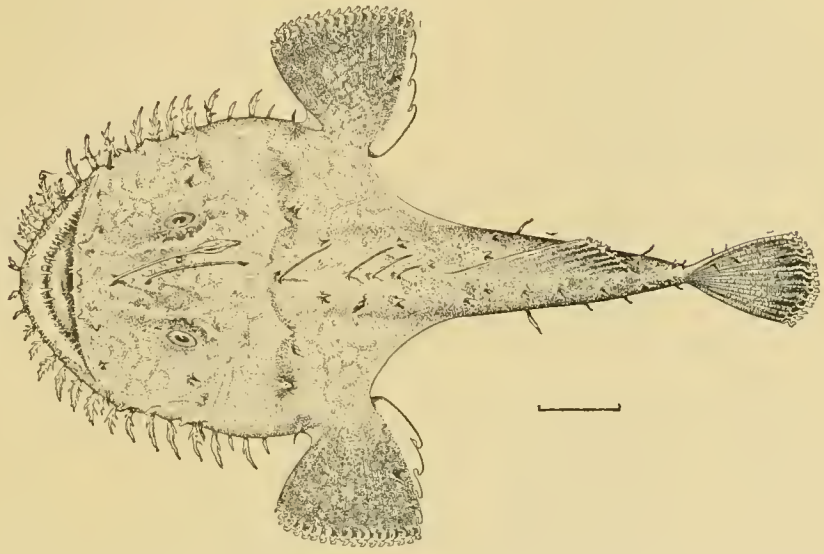


Fig. 67. *Lophius litulon* (Jordan & Sindo). (Proc. U. S. N. M., Vol. XXIV, p. 365.)

254. **Lophiomus setigerus** (Vahl).
Seen in the Fusan Museum.

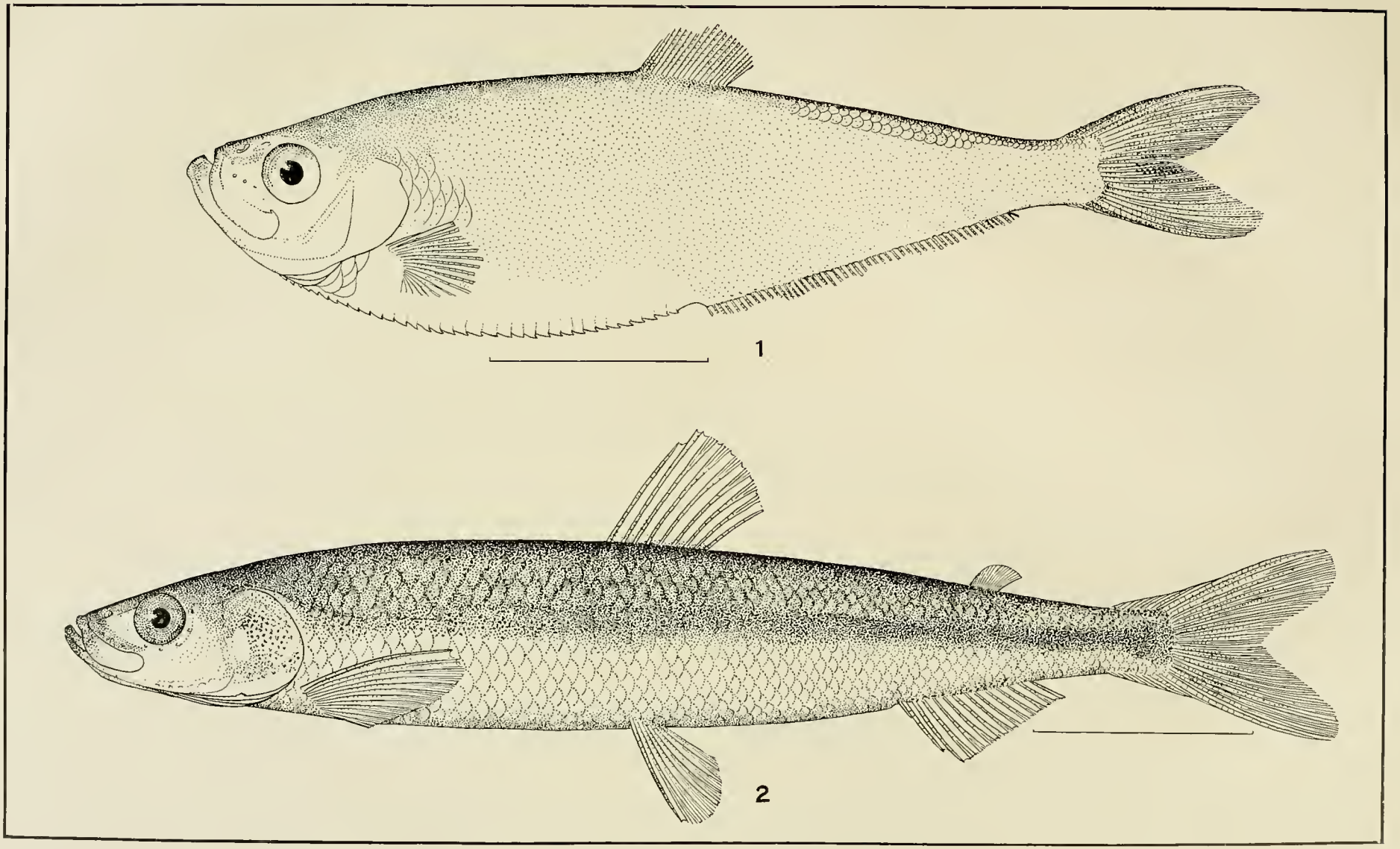


FIG. 1. *Zunasia chinensis* (BASILEWSKY). 5 in. C. M. Cat. No. 4569.
FIG. 2. *Spirinchus verecundus* JORDAN & METZ. (Type.) 5.75 in. C. M. Cat. No. 4570.

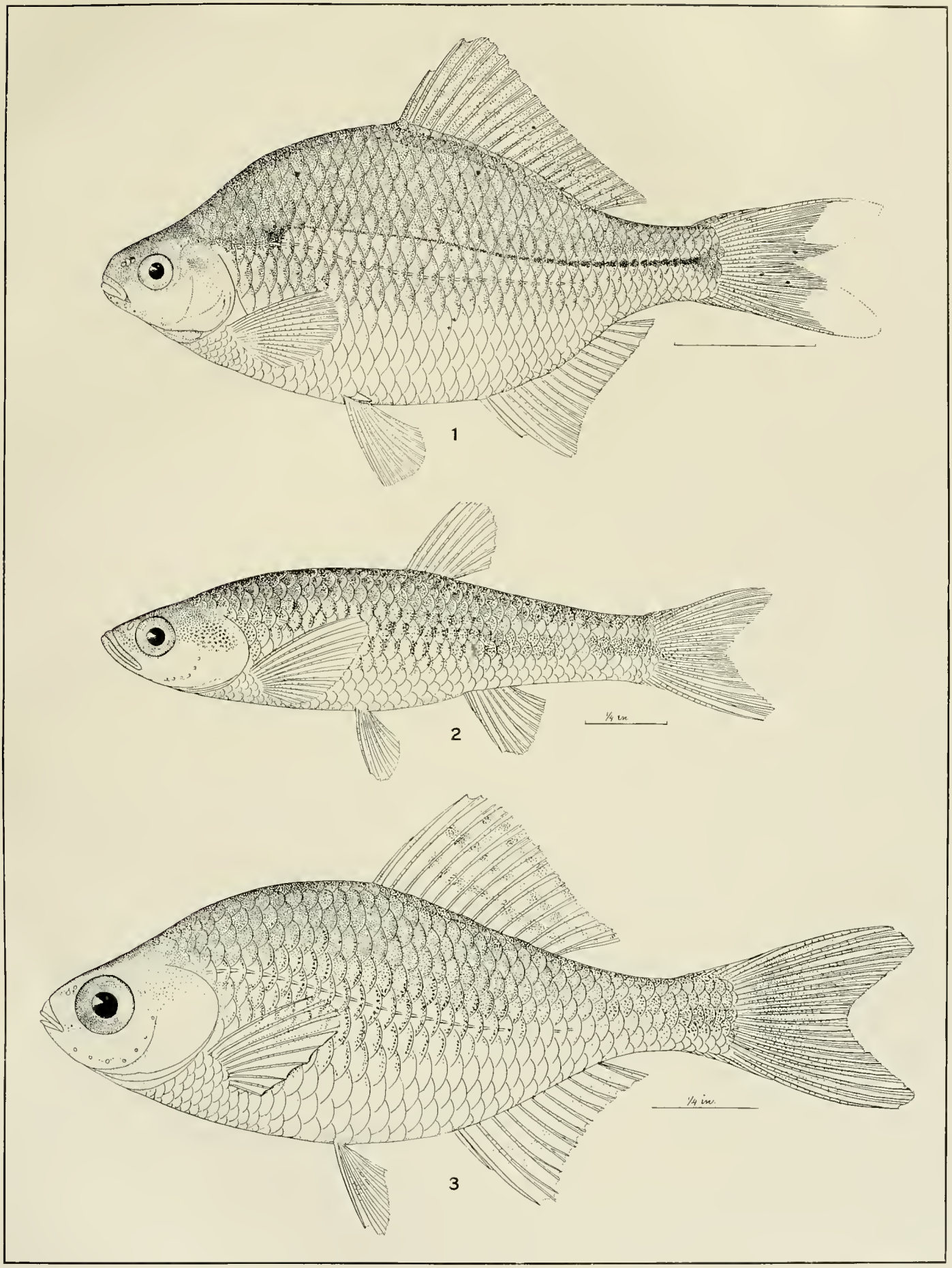
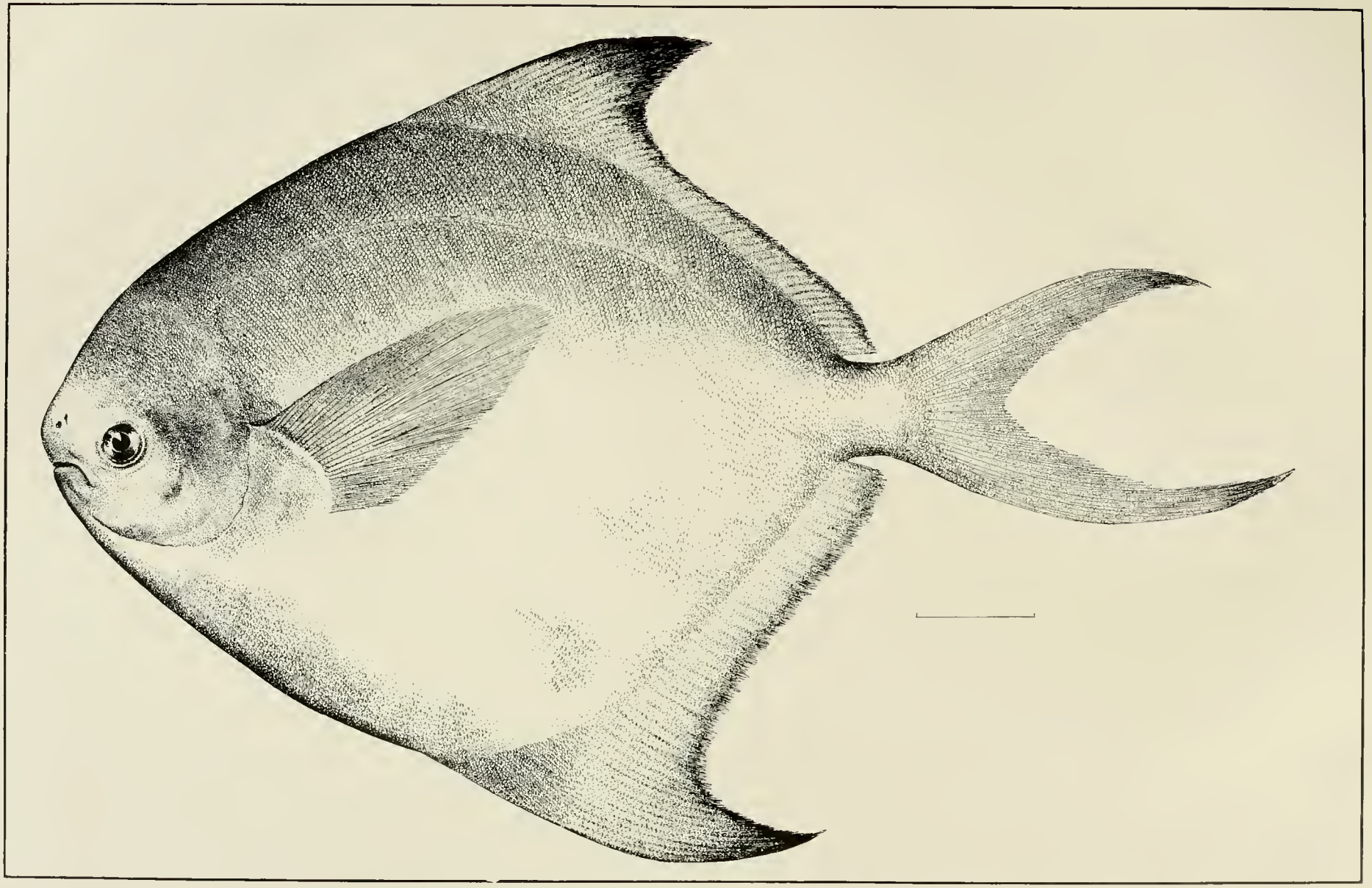
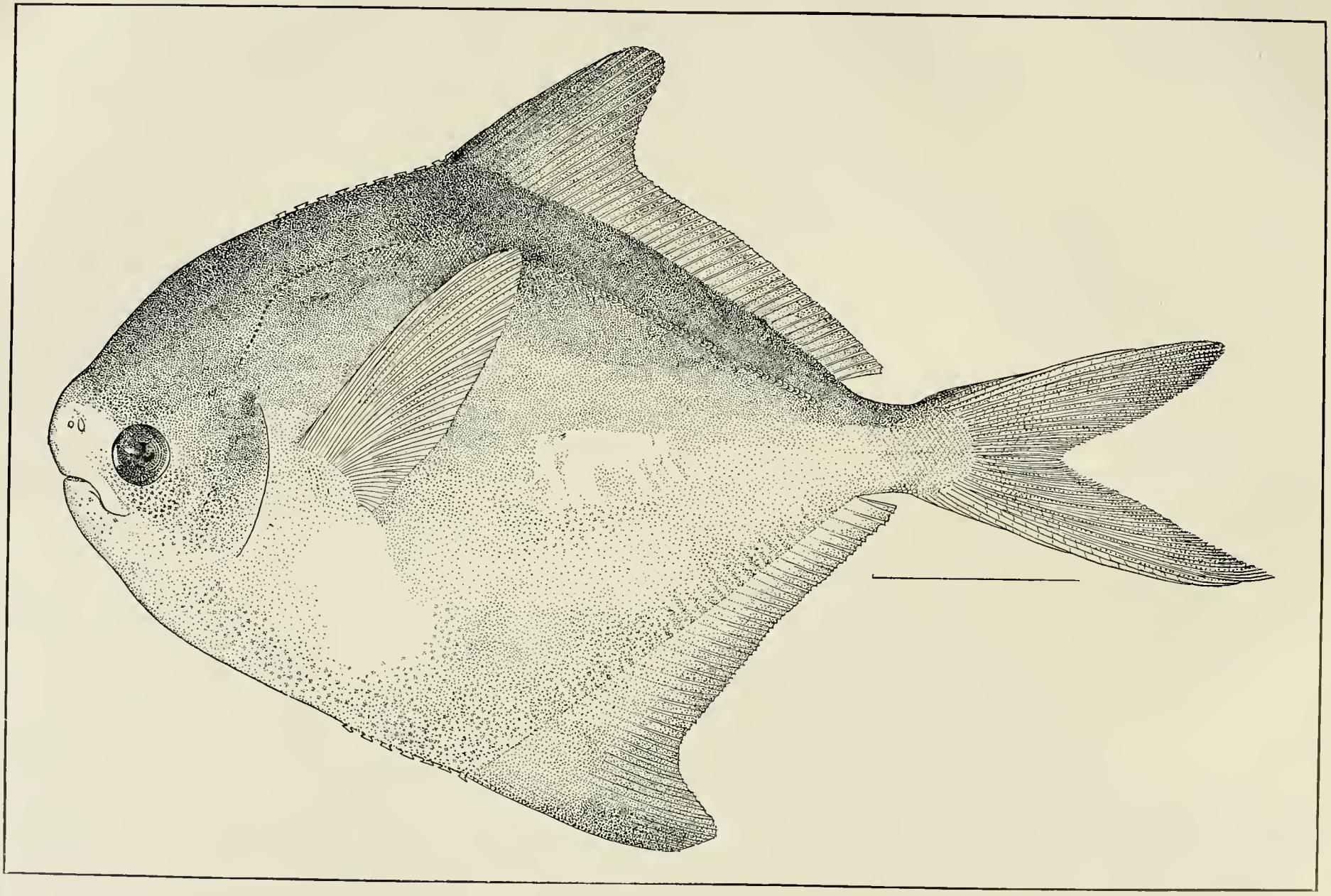


FIG. 1. *Acanthorhodeus asmussi* BERG. 5.5 in. C. M. Cat. No. 4571.
FIG. 2. *Rhodeus chosenicus* JORDAN & METZ. (Type.) 2 in. C. M. Cat. No. 4567.
FIG. 3. *Pseudoperilampus hondæ* JORDAN & METZ. (Type.) 2 in. C. M. Cat. No. 4566.

FIG. 1. *Parapelecus eigenmanni* JORDAN & METZ. (Type.) 5.5 in. C. M. Cat. No. 4565.
FIG. 2. *Pseudaspius bergi* JORDAN & METZ. (Type.) 4 in. C. M. Cat. No. 4563.
FIG. 3. *Pseudaspius modestus* JORDAN & METZ. (Type.) 2 in. C. M. Cat. No. 4560.



Stromateoides argenteus (EUPHRASEN). 10.5 in. C. M. Cat. No. 4117.



Stromateoides echinogaster (BASILEWSKY). 5.75 in. C. M. Cat. No. 4572.

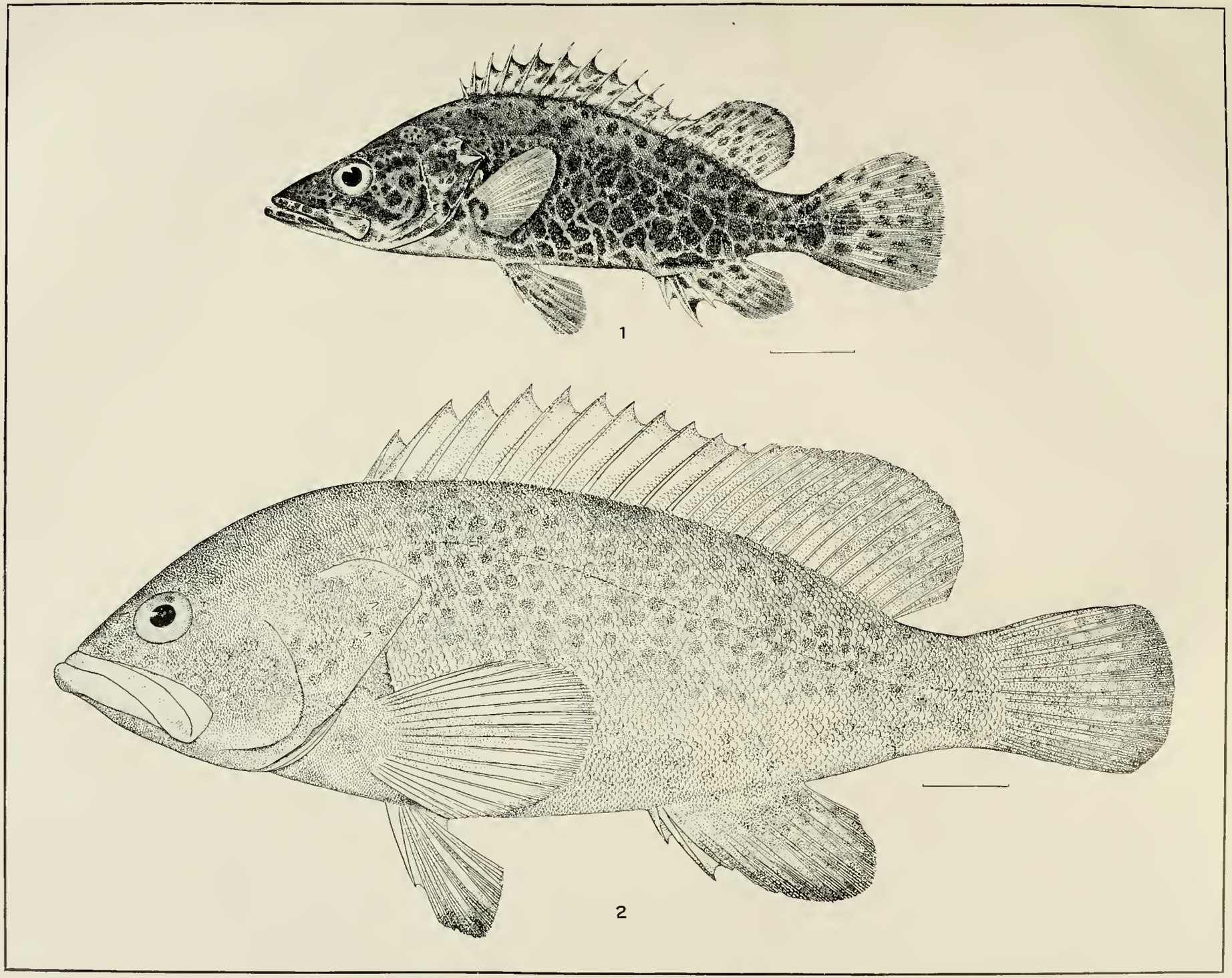


FIG. 1. *Siniperca scherzeri* STEINDACHNER. 8 in. C. M. Cat. No. 4173.
FIG. 2. *Epinephelus ionthas* JORDAN & METZ. 13 in. C. M. Cat. No. 4559.

FIG. 1. *Sciæna japonica* (TEMMINCK & SCHLEGEL). 15.25 in. C. M. Cat. No. 4581.
FIG. 2. *Sciæna iharæ* JORDAN & METZ. (Type.) 14 in. C. M. Cat. No. 4371.

FIG. 1. *Spheroides basilewskianus* (BASILEWSKY). 9.75 in. C. M. Cat. No. 4573.
FIG. 2. *Pleurogrammus azonus* JORDAN & METZ. (Type.) 14 in. C. M. Cat. No. 4558.

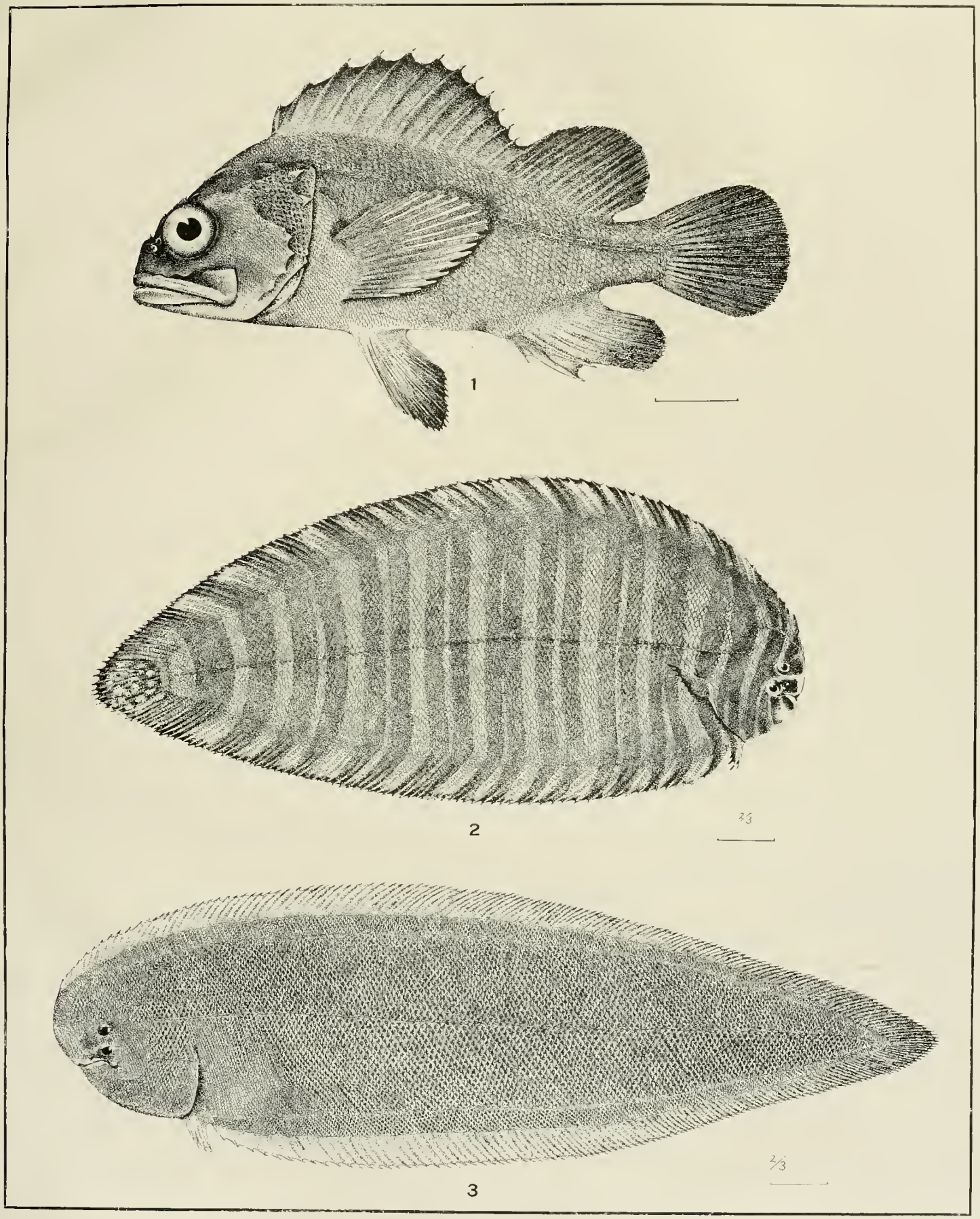
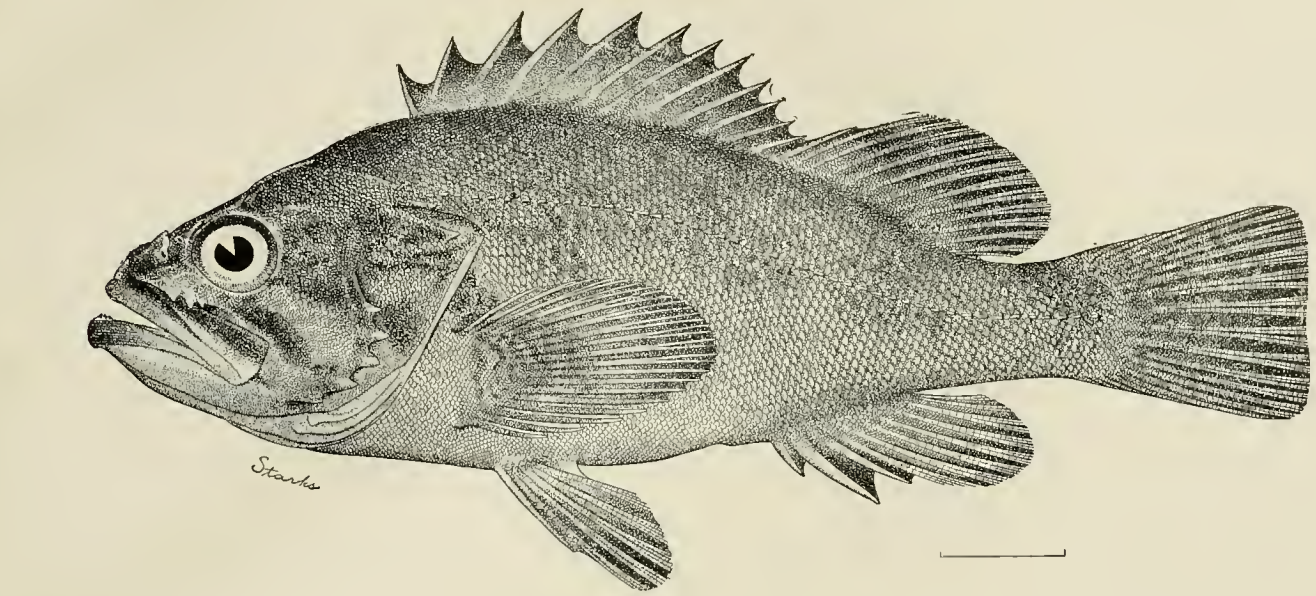
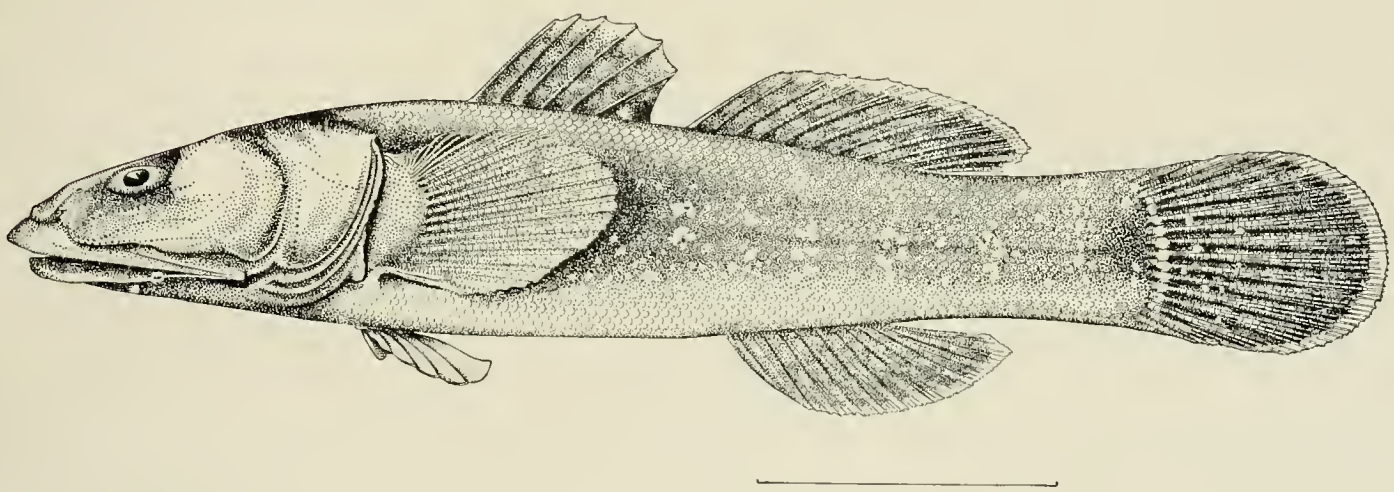


FIG. 1. *Sebastodes ijimæ* JORDAN & METZ. (Type.) 6.25 in. C. M. Cat. No. 4172.
FIG. 2. *Zebrias fasciatus* (BASILEWSKY). 7.8 in. C. M. Cat. No. 4574.
FIG. 3. *Areliscus hollandi* JORDAN & METZ. 14.75 in. C. M. Cat. No. 4369.





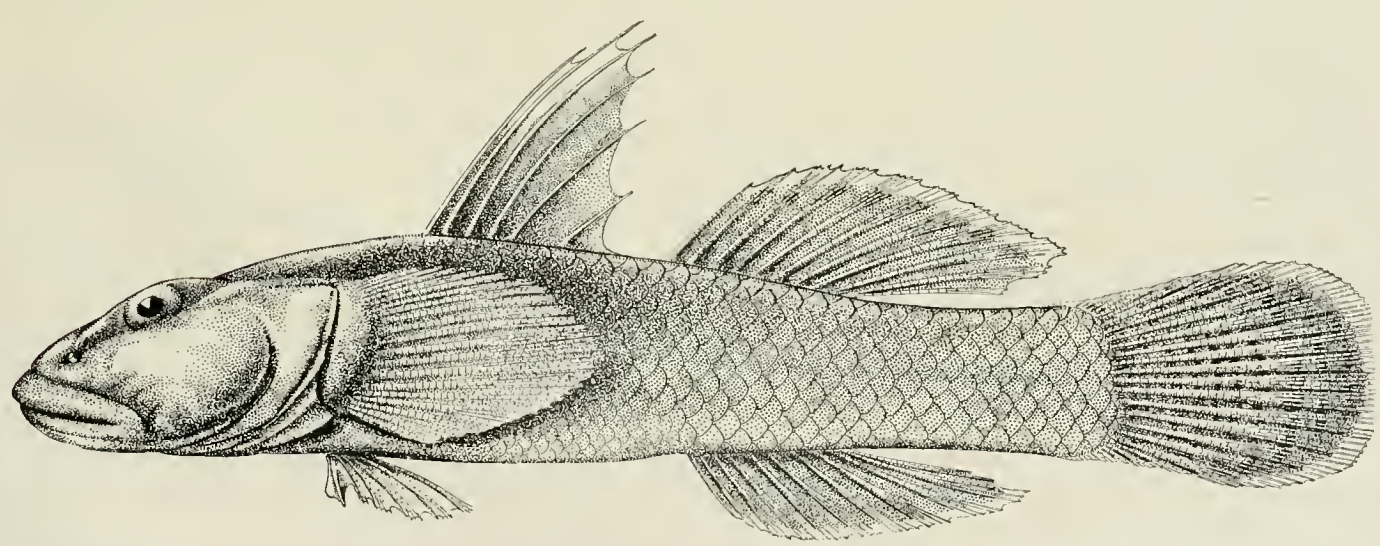


FIG. 1. *Sebastodes schlegeli* (HILGENDORF). After JORDAN & STARKS, Proc. U. S. N. M., Vol. XXVII, Pl. II.
FIG. 2. *Chasmichthys gulosus* (SAUVAGE). After JORDAN & SNYDER, Proc. U. S. N. M., Vol. XXIII, Pl. XXXVI.
FIG. 3. *Ctenogobius similis* (GILL). After JORDAN & SNYDER, Proc. U. S. N. M., Vol. XXIII, Pl. XXXV.

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VOL. VI. NO. 2.

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THE LANTERN-FISHES OF JAPAN

BY CHARLES H. GILBERT

PITTSBURGH.

PUBLISHED BY THE AUTHORITY OF THE BOARD OF TRUSTEES OF THE

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August, 1913.

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. 2.

THE LANTERN-FISHES OF JAPAN.

By Charles H. Gilbert,
Professor of Zoology, Stanford University.

(Plates XI–XIV.)

As the eastern coasts of Japan are swept by the Kurosiwo, the northern branch of the equatorial current, it should be expected that the *Myctophidæ*, or Lantern-fishes, in common with other strictly pelagic organisms, would be present in large numbers. But up to the present only three species[1] have been reported from this region, and these based on the well-known collections made by Mr. Alan Owston of Yokohama in Sagami Bay. Further rich collections by Mr. Owston have been recently secured for the Carnegie Museum by Dr. David Starr Jordan, and the Myctophids of this collection have been very kindly placed in the hands of the writer for study. There also have been available in this connection the extensive collections of Lantern-fishes made by the U. S. Bureau of Fisheries Steamer "Albatross" in Japanese waters in 1906. An account of the latter is here included by permission of the Commissioner of Fisheries.

Thirty species are here recorded, and, as these do not include *Macrostoma japonicum* of the previous list, the total now known from the waters of Japan is thirty-one. Twelve of these belong to the genera *Dasyscopelus*, *Myctophum*, and *Centrobranchus*, and constitute a group, which are usually light in color,

[1] *Neoscopelus alcocki, Diaphus watasei, Macrostoma quercinum japonicum.*

with much silvery pigment on the sides, and are taken at the surface, or at least not far below. Two of these species are here described as new, so nothing is known of their distribution in other waters. But it is worthy of note that the remaining members of the surface-group are well-known forms of wide distribution, two of them having been reported from the eastern Pacific as well as from Japan, the remainder having been recorded from all three of the great oceans.

A second group comprises the genera *Diaphus* and *Lampanyctus* (including *Macrostoma*). These are deeper pelagic forms, dark in color, with steely reflections, and are taken in intermediate nets, or enter the open dredge at intermediate depths. They seem to be more restricted in their range than the species which live nearer the surface, none of the Japanese forms being known to be cosmopolitan. Of the seventeen species here recorded from this group ten are described as new and hence are of unknown distribution; four are known also from the eastern Pacific;[2] two are known from the western Pacific[3] and the Indian Ocean, and one, *Lampanyctus niger*, while reported by Brauer from the Atlantic, Pacific, and Indian Oceans, is represented in collections by very few specimens, and has not been the subject of critical study.

All the species here recorded belong to tropical seas, with the exception of *Lampanyctus nannochir* and *Lampanyctus jordani*. *L. nannochir*, which was taken by the "Albatross" in the southern Okhotsk, is peculiar to the north Pacific, extending from Bering Sea to northern Japan and to southern California; *L. jordani* has been secured on two separate occasions off the coast of Hokkaido, and is not known elsewhere. The tropical species were abundant off the southern coasts of Kiusiu and as far north as Sagami Bay. Apparently they thin out rapidly north of Tokyo, as only a few individuals were encountered off Matsushima Bay. None were found in the Sea of Japan, even in the vicinity of the Straits of Tsushima, although numerous hauls with surface and intermediate nets were made.

List of Japanese Species of the Family MYCTOPHIDÆ.

Neoscopelus macrolepidotus Johnson.
Dasyscopelus *orientalis* sp. nov.
spinosus (Steindachner).
asper (Richardson).

[2] *Diaphus agassizi, Diaphus nanus, Lampanyctus townsendi, Lampanyctus nannochir.*

[3] *Diaphus cœrulcus, Lampanyctus macropterus.*

Myctophum affine (Lütken).
laternatum Garman.
evermanni Gilbert.
californiense Eigenmann & Eigenmann.
reinhardti (Lütken).
pterotum (Alcock).
suborbitale sp. nov.
valdiviæ Brauer.
Centrobranchus chœrocephalus Fowler.
Diaphus agassizi Gilbert.
nipponensis sp. nov.
nanus Gilbert.
tanakæ sp. nov.
glandulifer sp. nov.
anterorbitalis sp. nov.
gigas sp. nov.
cœruleus (Klunziger).
latus sp. nov.
sagamiensis sp. nov.
Lampanyctus townsendi Eigenmann & Eigenmann.
japonicus (Tanaka).
nannochir (Gilbert).
niger (Günther).
microchir sp. nov.
punctatissimus sp. nov.
jordani sp. nov.
macropterus (Brauer).

Genus Neoscopelus Johnson.

1. **Neoscopelus macrolepidotus** Johnson.

Neoscopelus macrolepidotus Johnson, Proc. Zool. Soc. Lond., 1863, p. 44, Pl. VII (Madeira).

Neoscopelus alcocki Jordan & Starks, Bull. U. S. Fish Com. for 1902 [1904], p. 580, Pl. 2, figs. 1 and 2 (Suruga Bay, Japan).

Several specimens were secured from Sagami Bay, and direct comparison of *N. alcocki* with Atlantic specimens (Albatross Station 2376, Gulf of Mexico) has

shown that the characters supposed to distinguish the Japanese species are fallacious. In Atlantic specimens also, as well as in those from Japan, the outer abdominal series of photophores ceases at about the vertical of the vent, while the second series continues along the base of the anal fin. Opposite the vent, the spots of the continuous series are very much reduced in size. They then rapidly increase opposite the anterior portion of the anal to diminish again at once, becoming very small opposite the posterior half of the anal fin. They are large again on the basal portion of the caudal peduncle, and minute on its terminal portion. These oscillations in size are exactly followed in Pacific material from Japan and the Hawaiian Islands. Atlantic specimens have also the curved series of small photophores around the vent. Careful comparison has failed to exhibit any differences.

Genus Dasyscopelus Günther.

Key to Japanese Species of Dasyscopelus.

a. Anal photophores 7 or 8 in the anterior group, 2 or 4 in the posterior, 7 + 3 the prevailing number. Supra-anals straight or very slightly angulated. No band of long spines along base of anal fin. **D. orientalis.**

aa. Anal photophores 6 to 8 in the anterior group, 5 to 8 in the posterior, 7 + 6 or 7 + 7 the prevailing numbers.

b. Supra-anals in a straight oblique line. Adults with the scales along the base of anal developing a specialized band of long spines..... **D. spinosus.**

bb. Supra-anals distinctly angulated. No band of spines along base of anal..... **D. asper.**

2. **Dasyscopelus orientalis** sp. nov. (Plate XI, fig. 1.)

Type 67 mm. long to base of caudal, from Misaki, Sagami Bay; Alan Owston, collector. (C. M. No. 6313.)

Closely allied to *D. pristilepis* Gilbert & Cramer, differing in the deeper body, smaller eye, more spinous scales, and in the reduction by one in the number of anal photophores. In the arrangement of the photophores, the two species wholly agree with each other, and also with *D. spinosus* and *D. opalinus*, but the species are well distinguished by the character of the scales, number of photophores, and by other details.

Measurements in hundredths of length without caudal: Length of head 28; diameter of eye 10; length of snout 5; length of longest gill-raker 5.5; interorbital width 7; length of maxillary 18; greatest depth 26; depth of caudal peduncle 9; distance from tip of snout to front of dorsal 43; to front of adipose fin 76; to base of ventrals 42; to front of anal 59; length of anal base 28; length of pectorals 26.

Dorsal rays 13; anal rays 18; ventrals with outer rudiment and 8 developed rays; pectoral rays 16. Scales of lateral line 36.

Eye large, though smaller than in *D. pristilepis*, its upper margin but little below the profile, the rounded snout protruding beyond the orbit for a distance equal to half the diameter of the eye. Teeth minute, in narrow bands on jaws, in two small round patches on head of vomer, the narrow band on palatines separated from vomer by a very short interspace. Cleft of mouth oblique; maxillary decidedly broadened at tip, extending but slightly beyond vertical from hinder margin of eye. Preopercular border nearly vertical, the cheeks not obliquely lengthened. Gill-rakers long and slender, the longest half the diameter of the eye, 4 + 15 in number (counted in one of the cotypes). Pectorals long and slender, usually reaching the vertical from the vent and extending to or slightly beyond the middle supra-anal photophore. Scales firm, all sharply spinous, including those of the lateral line and those on breast and belly. The spines are everywhere approximately equal, not greatly lengthened along the base of the anal fin as in *D. spinosus*. In *D. pristilepis*, the scales are thinner and less extensively spinous, the scales of the lateral line have few spines, or none, and those on breast and belly are smooth. In *D. orientalis*, the scales of the lateral line are moderately enlarged, their vertical diameter equaling their distance from the base of the dorsal fin.

Photophores.—A very faint pre-orbital immediately above nostril, and one better marked under the lower anterior border of the eye. Suprapectoral separated from lateral line by twice its distance from base of upper pectoral ray. Infrapectorals in line with first ventral, their interspace less than that separating the upper one from the suprapectoral. First pair of thoracics nearest the median line, the third and fourth pairs equidistant from it, the fifth pair widely divergent, inserted immediately in front of the outer ventral rays. Interval between the third and fourth pairs the shortest, that between fourth and fifth but little longer, the second interval a little shorter than the first. Supraventral vertically above the first ventral, very slightly nearer base of ventral fin than lateral line. First pair of ventrals nearly in contact, the others a little more elevated, slightly converging from the second to the fourth, which are at the sides of the vent and a little anterior to it; first ventral interval a little longer than the second, the third the shortest. Upper supra-anal immediately below but not in contact with the lateral line, on its seventeenth or eighteenth scale, in a vertical line which traverses the base of the second or third anal ray; upper and middle supra-anals in a line passing through fourth ventral, the lower

supra-anal slightly in advance of this line. Different individuals among the cotypes vary with respect to the relation of the supra-anals, some having them in a straight line, others having them very slightly angulated, as in the type. Antero-anals a little curved, the first slightly nearer base of fin. Anals 7 + 3 in the type, and this is the prevailing number in this species. The antero-anals may be seven or eight, the posterior group two, three, or four. On one side of one specimen only six antero-anals were found. One hundred and twenty-six specimens were examined, the two sides being listed separately. In these 6 + 4 occurred once, 7 + 2 in five cases, 7 + 3 in one hundred and eighty-nine cases, 7 + 4 in seventeen, 8 + 2 in sixteen, 8 + 3 in twenty-four cases. Taking the two groups separately, in the anterior 6 occurred once, 7 two hundred and eleven times, 8 occurred forty times; in the posterior group, 2 occurred twenty-one times, 3 two hundred and thirteen times, and 4 eighteen times. The total number in both groups varies from 9 to 11. One hundred and seventeen of the one hundred and twenty-six specimens were bilaterally symmetrical with regard to their photophores. The first pair of the postero-anals is above the last anal rays. Posterolateral immediately below lateral line, but not in contact with it, slightly behind vertical from last antero-anal. Precaudals two, in an oblique line, the interspace very little, if at all, greater than that between the postero-anals. No luminous areas on back, or on inferior surface of caudal peduncle, in any of the numerous adults of the collection.

Color in spirits uniform dusky brownish on upper parts and on sides of body, profusely dotted with fine black specks. Abdomen and lower side of head silvery. A lengthwise black streak on upper part of pectoral, beginning near base and widening backwards for about the basal third of the length of the fin.

This is evidently one of the most abundant species in Japanese waters. Numerous adults were obtained from Misaki, on Sagami Bay (C. M. Nos. 4614, 4615, 4616) and many immature examples were taken by the "Albatross" at the following Stations:

4921. West of Colnett Straits. Surface.

4954. Kurosiwo, east of Kagoshima. Intermediate net, 850 fathoms.

4955. Kurosiwo, east of Kagoshima. Surface.

At Station 4954, the specimens probably entered the net at or near the surface.

The type is deposited in the U. S. National Museum.

3. **Dasyscopelus spinosus** (Steindachner).

Scopelus spinosus Steindachner, Ichth. Notiz. V, 1867, p. 11, Pl. III, fig. 4 (China).

A few specimens were secured by the "Albatross" at the surface at Station 4921, south of Kagoshima (30° 23′ 30″ N., 129° 36′ 30″ E.). They are somewhat slenderer than Hawaiian specimens, and have the line of the supra-anals noticeably more oblique, the anterior of the series being above the interspace between third and fourth ventrals, instead of vertically above the fourth ventral as in Hawaiian material. At a Station in the South Pacific (16° 39′ S., 149° 11′ W.), the "Albatross" secured in 1899 nine specimens, of which five are of the slender type with oblique supra-anals, and four of the deeper form with steep line of supra-anals. There is no transition between the two, and although the differences are of small magnitude, they merit attention and should be noted in future collections from the Pacific.

The number of anal photophores in the five Japanese specimens ranges as follows: 6 + 6 (1), 6 + 7 (2), 7 + 5 (3), 7 + 6 (4), the two sides of each specimen being listed separately. The sum of the two groups is either 12 or 13, while in Hawaiian material it ranges from 13 to 15, with 14 prevailing (Gilbert, Bull. U. S. Fish Com. for 1903 [1905], Part 2, p. 559). This smaller number in the slender form may account for the smaller average number reported in South Sea material as compared with that from Hawaii (Gilbert, Mem. Mus. Comp. Zool., XXVI, 1908, p. 220). In the five slender specimens from the South Pacific above referred to, the anal photophores are 7 + 6 on both sides of each; in the four deep specimens from the same locality, the following numbers occur: 6 + 7 (2), 6 + 8 (1), 7 + 5 (2), 7 + 6 (2), 7 + 7 (1).

4. **Dasyscopelus asper** (Richardson).

Myctophum asperum Richardson, Voy. Erebus and Terror, 1845, p. 41, Pl. XXVII, figs. 13 to 15; habitat unknown.

In addition to the characters which have been mentioned as distinguishing this species from the nearly related *D. spinosus*, may be given the slenderer form, the decidedly wider, blunter head, the fewer gill-rakers, and the absence of the clusters of long spines, which in *D. spinosus* are attached to the scales covering the ventral series of photophores. Comparing a Japanese specimen of *D. asper*, 78 mm. long to base of caudal, with one of *D. spinosus*, 92 mm. long to base of caudal, we have the following measurements in hundredths of length as above indicated:

	asper	*spinosus*
Length of head	27	27.5
Diameter of eye	10	11
Width of snout at nostrils	8	6
Length of maxillary	15	17
Greatest depth of body	24	27
Dorsal rays	12	14
Anal rays	18	19
Pectoral rays	16	15
Scales in lateral line	39	39

In *D. asper*, the head is but little narrowed anteriorly, the upper orbital margins are nearly parallel, and the snout is high and bluntly rounded, protruding a trifle on the level of the nostrils. In *D. spinosus* the head narrows rapidly forward, the orbital margins strongly converge, the snout is not bluntly rounded and protrudes farthest at the premaxillaries.

In *D. asper*, the gill-rakers are somewhat shorter and heavier, 5 + 10 or 5 + 11 in number; in *D. spinosus* 7 + 16.

In *D. spinosus*, each scale covering a photophore of the ventral series develops long slender spines many times larger than those on neighboring scales. These are specially developed along the base of the anal fin, where the spines overlap and form a dense band. No such enlarged spines are present in *D. asper*.

Brauer finds the eye smaller than heretofore given for *D. asper*, but in adults it is but little less than two-fifths the length of the head, and is progressively smaller in the young.

Photophores.—The superior preorbital is usually concealed, but the inferior is conspicuous. The suprapectoral is higher than in *D. spinosus*, constantly nearer the lateral line than the base of the pectoral. From the first to the fourth, the thoracics form two evenly diverging lines, the fifth far out at the sides, opposite the outer ventral ray; the spacing of the pairs is nearly equal, the interval between third and fourth pairs shortest. Supraventral midway between lateral line and base of ventral (not nearer lateral line as in Brauer's figure). First pair of ventrals fully exposed, the two covered by a single much enlarged scale of the median series, in addition to the small special scales thus wholly overlapped; second pair somewhat farther out at the sides, forming with the third and fourth two lines gently converging backwards; the four pairs are equally spaced. Supra-anals in a very blunt angle, the anterior obliquely in front of and below the second. The upper is immediately below the lateral

line just in advance of vertical from third ventral, the second behind that from fourth ventral. The antero-anals are slightly curved, the anterior spot a little nearer the base of the anal fin. Posterolateral close under the lateral line, vertically over the last antero-anal. Only the first postero-anal over the last anal rays. In thirteen specimens, the combinations found have been as follows:

7 + 5 in 2 cases, 7 + 7 in 3 cases,
7 + 6 in 14 cases, 8 + 5 in 3 cases,
8 + 6 in 4 cases.

The number is thus seen to agree with the range in *D. spinosus*. The precaudals are also similar, placed at a slight angle and a little farther apart than the spots of the anal series.

The scales develop serrations in extreme youth; well-developed spines are present in individuals 25 mm. long. As in *D. spinosus*, the luminous plates develop late. No trace of them is to be found in specimens 65 mm. long. In a male 85 mm. long, there are five overlapping luminous scales on the dorsal side of the caudal peduncle, and in a female 100 mm. long, there is a single plate below.

Specimens were obtained along the southern and eastern coasts of Japan, at the surface, from the vicinity of Nagasaki to Matsushima Bay.

Lists of Stations.

4909.	31° 38′ 30″ N.,	129° 27′ 30″ E.	Intermediate net, 300 fathoms.
4910.	31° 37′ 40″ N.,	129° 26′ 00″ E.	Surface.
4921.	30° 23′ 30″ N.,	129° 36′ 30″ E.	Surface.
4973.	33° 24′ 15″ N.,	135° 30′ 30″ E.	600 fathoms.
5052.	37° 57′ 45″ N.,	142° 04′ 00″ E.	Surface.
5081.	34° 14′ 00″ N.,	138° 05′ 00″ E.	Surface.

At Stations 4909 and 4973 the fish probably entered the open net near the surface.

Genus Myctophum Rafinesque.

(*Scopelus* Cuvier.)

Key to Japanese Species of Myctophum.

a. No photophores above the lateral line.
  b. Supra-anal photophores in an oblique row.
    c. Second ventral photophore not out of line with the others. Postero-anals 5 to 7 in number ..... **M. affine.**
    cc. Second ventral photophore more elevated than the others. Postero-anals 2 or 3 in number ..... **M. laternatum.**

bb. Supra-anal photophores angulated.

d. Second ventral photophore not elevated.

e. A single posterolateral. Second precaudal little above the first, far below the lateral line.

f. All postero-anals behind the anal fin; 4 to 6 in number. **M. evermanni.**

ff. First postero-anals above the anal fin; 8 to 11 in number. **M. californiense.**

ee. Two posterolaterals. Anterior postero-anals above the anal fin. Second precaudal widely separated from the first..... **M. reinhardti.**

dd. Second ventral elevated, vertically above the first.

g. No suborbital photophore. First two supra-anals in line with the supra-ventral..... **M. pterotum.**

gg. A large suborbital photophore. First two supra-anals in line with the second (elevated) ventral..... **M. suborbitale.**

aa. Four photophores above the lateral line, near the dorsal profile..... **M. valdiviæ.**

5. **Myctophum affine** (Lütken).

Scopelus affinis Lütken, Vidensk. Selsk. Skr., (6), 1892, p. 252, fig. 10; Atlantic and Indian Oceans.

Seventeen immature specimens were secured at the surface from Matsushima Bay and to the southward. In none of these specimens are the supra-anal photophores angulated and the precaudals obliquely placed and distant, as figured for this species by Brauer (Die Tiefsee Fische, 1906, p. 191, fig. 106), nor have these conditions been present in any of the very numerous examples examined from various parts of the Pacific. The supra-anals are in a perfectly straight line, or the middle one of the series (never the lower one) is rarely very slightly advanced.

The number of anal photophores is subject to wide variation in this form, if the entire range of the species in all oceans is taken into account; but in any one locality, or group of contiguous localities, the variation is much more restricted, and is grouped about the mode in a symmetrical manner. It is important to determine the variation curve in as large a number of individuals as possible, as a contribution to the regional variation of pelagic forms. The lantern-fishes are especially well adapted to this study, as the photophores vary regionally under conditions, which seem to leave the remainder of the organism unmodified, and serve therefore as a more delicate gauge of slight divergence than is usually available.

The number of specimens in the present collection is too small to enable us to determine finally the range of variation of the antero-anal and postero-anal photophores in Japanese waters, but seems to indicate a close correspondence

with that determined for the seas about the Hawaiian Islands (Gilbert, Deep Sea Fishes, Hawaiian Islands, 1905, p. 596; *M. margaritatum* = *M. affine*). The total number in both series ranges from 14 to 16 (in Hawaii from 13 to 17), the antero-anals ranging from 8 to 10, the postero-anals from 5 to 7. Listing separately the two sides of the 17 individuals:

Antero-anals— 8 occur in 5 cases,	Postero-anals—5 occur in 2 cases,
9 occur in 27 cases,	6 occur in 28 cases,
10 occur in 2 cases.	7 occur in 4 cases.

The following combinations occur:

8 + 6 in 3 cases,	9 + 6 in 23 cases,
8 + 7 in 2 cases,	9 + 7 in 2 cases,
9 + 5 in 2 cases,	10 + 6 in 2 cases.

Twelve of the seventeen specimens were bilaterally symmetrical, the other five varying on the two sides by one photophore in either the anterior or the posterior group.

In a small collection ranging from the latitude of the Hawaiian Islands to the equator, reported on by the writer (Mem. Mus. Comp. Zool., XXVI, 1908, p. 217), a tendency seemed apparent toward a reduction southward in the number of the photophores of the anal series. More material from this region and that south of the equator is highly desirable.

List of Stations.

4921.	30° 23′ 30″ N.,	129° 36′ 30″ E.	Surface.
4927.	29° 57′ 00″ N.,	130° 41′ 00″ E.	Surface.
4978.	33° 57′ 45″ N.,	135° 56′ 00″ E.	Surface.
5052.	37° 57′ 45″ N.,	142° 04′ 00″ E.	Surface.

6. **Myctophum laternatum** Garman.

Myctophum laternatum Garman, Mem. Mus. Comp. Zool., Vol. XXIV, 1899, p. 267, Pl. 56, fig. 1; west coast Central America, Gulf of California.

This diminutive species was recorded by Garman from the Gulf of California and the coast of Panama, and by Brauer from the west coast of Africa and from various localities in the Indian Ocean. Four specimens were taken by the "Albatross" near Nagasaki, in intermediate nets at 300 fathoms (Stations: 4909, 31° 28′ 30″ N., 129° 27′ 30″ E.; 4920, 30° 34′ N., 129° 22′ E.). The

largest, 20 mm. in length, has no trace of luminous plates on the caudal peduncle. The material has been directly compared with specimens from the eastern Pacific and no difference found. Young individuals of *Dasyscopelus orientalis* from the same region must be carefully distinguished. A specimen of the latter, 28 mm. long, has the scales without trace of spines. The number and distribution of the photophores are the same, but the eye in *D. orientalis* is larger, the photophores themselves are larger, there is a preorbital below the nostril more conspicuous than the one above, the lower subpectoral is decidedly below the level of the upper, the second ventral is not more elevated than the others and the precaudals are closely crowded. In *M. laternatum*, the first ventrals are closely apposed, the second far out at the sides, the third and fourth intermediate in position; the precaudals are much more widely separated than the postero-anals.

7. **Myctophum californiense** Eigenmann and Eigenmann.

Myctophum californiense Eigenmann and Eigenmann, West. Amer. Sci., 1889, p. 124; San Diego, Cal.

A single adult male, 127 mm. long, from Station 5034, south of Nemuoro, Hokkaido (43° 05′ 30″ N., 145° 57′ 40″ E.); and two adult females of the same size from Sagami Bay (C. M. No. 4607).

This species usually has been considered identical with *M. humboldti*, but examination of the type and a cotype of *californiense* from San Diego, of a third specimen from off the coast of Lower California, and the three specimens here recorded from Japan, shows agreement in a combination of minor characters which indicate specific difference from *humboldti*. These characters are as follows:

1. Pectoral rays 17 or 18 (12 to 14 in *humboldti*).

2. Entire back of caudal peduncle in adult males covered by a series of distinct luminous plates, each of which is surrounded by black pigment and separated from the adjoining plates. The series contains six large plates and may in addition contain one or two minute ones immediately behind the adipose. These are present in the type of the species and in one of the Japanese specimens. In *M. humboldti*, there are never more than one or two small inconspicuous plates on the back of the caudal peduncle. In the adult females from Japan, there are seven or eight distinct plates covering the area between the anal fin and the caudal.

3. The line of the antero-anals is nearly or entirely straight, while in

humboldti it is strongly arched, with the first one or two of the series nearer the base of the anal than the succeeding spots. The spots of the anal series are distinctly smaller and more crowded than the others, and more so than in *humboldti*.

4. Posterolateral slightly behind the vertical from the last antero-anal (in front of this vertical in *humboldti*).

5. Postero-anals more numerous, 8, 9, 10, and 11 in the six specimens known, three of them having 10 on each side. The range in *humboldti* cannot yet be given, as both Lütken and Brauer have unquestionably confused more than one species under that name. Both authors agree that typical examples from the Mediterranean have 8 postero-anals, which probably indicates a range of 7 to 9.

6. Middle pectoral photophore midway between the upper and the lower, or very slightly nearer the lower. In typical *humboldti*, it is considerably nearer the lower than the upper.

7. Anterior supra-anal somewhat behind vertical from second ventral (in advance of this point in *humboldti*).

Measurements of the male Japanese specimen in hundredths of the length to base of caudal (103 mm.): Length of head 25; diameter of eye 7.8; length of snout 5; length of maxillary 15.5; greatest depth of body 20; least depth 8.5; distance from tip of snout to front of dorsal 44; to adipose 76; to base of ventrals 40; to front of anal 58; from last anal ray to middle of caudal base 19; length of base of dorsal 15.5; of anal 25.

Dorsal rays 15; anal rays 22; pectoral rays 17; ventral rays 9, the outer ray a short rudiment. Scales of lateral line 42. Gill-rakers very long and slender, 6 + 19.

Photophores.—Three pectorals equally spaced, the upper equidistant from the upper pectoral ray and from the nearest point on the lateral line. First three pairs of thoracics forming regularly diverging lines, the fourth pair again lower, the fifth much divergent, at base of outer ventral rays. Supraventral halfway between the lateral line and the base of ventrals, distinctly above the horizontal line joining the first two supra-anals. First pair of ventrals partially concealed by the inner ventral rays, their interspace equal to that of the fourth pair, less than that of second and third pairs (first pair less separated in other specimens); distance between first and second and between third and fourth ventrals equal, that between second and third less. Anterior supra-anal on a level with the second, slightly behind the vertical from the second ventral;

second supra-anal above (or slightly in advance of) the fourth ventral, nearer the fourth ventral than the upper supra-anal, which is above the anus and scarcely in contact with the lateral line. Anals 7 + 10, small, close-set, in a straight line, the anterior not lower than the others; the last antero-anal is above the thirteenth anal ray, the fifth postero-anal over the last anal ray. Posterolateral somewhat behind the vertical from the last antero-anal, immediately below the lateral line. Precaudals obliquely placed, the second higher and separated from the first by a wider interval than that between the anal photophores.

The six large luminous plates on back of caudal peduncle are very conspicuous, as they are lustrous white on a black background. The scales are lost and the integument partly gone, but the general color seems to have been dusky, blackish at the base of the fins.

Myctophum boöps Richardson is probably a synonym of *M. humboldti*. The figure of the type gives thirteen rays in the pectoral fin, the description fifteen, both numbers within the known range of *humboldti*.

8. **Myctophum evermanni** Gilbert.

Myctophum evermanni Gilbert, Bull. U. S. Fish Com. for 1903 [1905], p. 597, Pl. 70, fig. 1; Hawaii.

Several young specimens agreeing wholly with types from the Hawaiian Islands were taken in the Eastern Sea off southern Japan. Listing separately the fifteen specimens of the collection, we have the following combinations of anal photophores:

7 + 5 (2); 7 + 6 (4); 8 + 4 (1); 8 + 5 (10); 8 + 6 (9); 9 + 5 (2); 9 + 6 (2).

Taken at Station 4921, 30° 23′ 30″ N., 129° 36′ 30″ E., at the surface.

9. **Myctophum reinhardti** (Lütken).

Scopelus reinhardti Lütken, Vidensk. Selsk. Skr., (6), 1892, p. 257, fig. 16; Atlantic.

Three young specimens agreeing wholly with Hawaiian material heretofore described (*Myctophum braueri* Gilbert, Bull. U. S. Fish Comm. for 1903 [1905], p. 598, Pl. 70, fig. 1).

Anal photophores 6 + 8 (3), or 7 + 7 (3).

List of Stations.

4927.	29° 57′ N.,	130° 41′ E.	Surface.
4954.	32° 05′ N.,	133° 02′ E.	Surface.
4955.	32° 32′ N.,	132° 39′ E.	Surface.

10. **Myctophum pterotum** (Alcock).

Scopelus (*Myctophum*) *pterotus* Alcock, Ann. Mag. Nat. Hist., 1890, p. 217; Indian Ocean.

Myctophum gilberti, Evermann and Seale, Bull. U. S. Bur. Fish., 1907, p. 55; Philippine Islands.

Sixty-five specimens were collected by Professor J. O. Snyder in the market at Kagoshima (C. M. No. 4600), and have been examined with reference to the excessive variation which Brauer has reported in this species. No indication of such variation is given in the Japanese material, nor in numerous specimens from the Eastern Pacific, with which we have compared it. On the contrary, both as regards number and position of the photophores, this seems to be a very constant type. Brauer's results were partly based on his failure to distinguish between *M. pterotum* and *M. fibulatum* Gilbert and Cramer, the latter from the Hawaiian Islands. The two species are perfectly distinct and can be recognized at a glance at any age after the photophores have developed. Brauer's text-figure 93 (Die Tiefsee Fische, 1906, p. 182) represents *M. fibulatum* and not *M. pterotum*, and may have been drawn from one of the specimens which Brauer examined from the Hawaiian Islands. Much is lost in this volume through the failure to specify the locality of specimens from which the drawings were made, and in general to discuss what are conceived to be variations of the different forms in relation to their geographic distribution.

M. pterotum is a diminutive species, the majority of mature specimens ranging from 50 to 60 mm. in total length, none yet reported in excess of 70 mm. Mature females of 50 mm. are in the Japanese material. In neither males nor females are there well-developed luminous plates on the caudal peduncle, such as figured by Brauer (*l. c.*, text-figure 94), but occasionally a very faint single luminous scale can be detected on the back of the caudal peduncle in both sexes. No luminous scales on the under surface of the caudal peduncle are present in any specimens.

In the arrangement of the photophores, *M. pterotum* differs constantly from *M. fibulatum* in the following respects: 1. The first and second supra-anals, the supraventral and the suprapectoral are in a straight line which passes obliquely forwards and upwards from the second supra-anal. In *M. fibulatum*, the line of the two lower supra-anals passes forwards and downwards, traversing the second (elevated) ventral, and leaving both supraventral and suprapectoral far above it.

2. Supraventral lower, its distance from lateral line half its distance from base of ventrals (one-third its distance from base of ventrals in *M. fibulatum*).

3. Suprapectoral lower, equidistant from pectoral base and lateral line (distance from lateral line half its distance from pectoral base in *M. fibulatum*).

4. Upper preopercular spot on level of middle of eye (on level of lower margin of eye in *M. fibulatum*).

5. Upper supra-anal and the posterolateral separated from lateral line by a space equal to their own diameter (almost touching the lateral line in *M. fibulatum*). In both species, the upper precaudal fails to touch the lateral line.

6. The elevated second ventral is over the middle of the interspace between the first and third ventral (almost vertically above the first ventral in *M. fibulatum*).

In addition to these characters, the eye in *M. pterotum* is much smaller and has constantly a round peculiarly contracted pupil, while in *M. fibulatum*, the eye is larger and the pupil is large and ovate in shape, the major axis passing from above downwards and backwards, and the upper portion of the iris is darkly pigmented while the lower half is silvery. In *M. pterotum*, the opercle terminates in a long tongue-shaped process, which covers the suprapectoral photophore and extends above the pectoral fin and beyond its base. This process is not present in *M. fibulatum*. The latter is a larger species, reaching a length of at least 100 mm. The mature female develops a single luminous scale on the back of the caudal peduncle, the male may develop two.

In Japanese specimens of *M. pterotum*, the prevailing number of anal photophores is 6 + 4, this number occurring on both sides of fifty-six of the sixty-five individuals, and on one side of four others. Total combinations are 5 + 4 (2), 5 + 5 (7), 6 + 3 (2), 6 + 4 (116), and 6 + 5 (3).

The antero-anals are always in a curved line, the first much nearer the anal base than the others, the first and second more widely spaced than the following.

11. **Myctophum suborbitale** sp. nov.

Type 17 mm. long to base of caudal fin, from Station 5064, in Suruga Bay; taken in open intermediate net down to 300 fathoms.

Closely allied to *M. pterotum* and *M. fibulatum*, but differing from these and all other species of the genus in the presence of a small round photophore on the cheek below the posterior portion of the eye.

Measurements in hundredths of length without the caudal fin: Length of head 35; diameter of eye 13; length of snout 5.5; length of maxillary 23; depth of body 25; of caudal peduncle 8; predorsal length 55; length of dorsal base 18; pre-anal length 60; length of anal base 28; length of pectoral fin 32.

Dorsal rays 12; anal rays 17; pectoral rays 11 or 12; ventral rays 8. Scales of lateral line 34.

Snout short, not bluntly rounded; mouth very oblique, the maxillary broadened posteriorly, extending well behind eye and nearly to the preopercular margin, which is not oblique. Eye large, more than one-third the length of the head. Opercle posteriorly extended, wholly covering the upper and lower pectoral photophores, notched opposite the pectoral base. Pectoral fin long, extending beyond the origin of the anal. Anal much longer than the dorsal, its origin under the middle of the dorsal base, its last ray under the adipose fin. Ventrals reaching the anus. Scales all fallen, the scars indicating that those along the lateral line were not at all enlarged.

Photophores.—A minute pre-orbital, on the dorsal side of the nostril. A well-developed subocular spot, not present in any other species of this genus, on cheek below the hinder part of the eye, near the maxillary border. Lower pre-opercular spot very small, opposite the expanded end of the maxillary, the upper large, placed entirely below the level of the eye, differing in this respect strikingly from its position in *M. pterotum*. Suprapectoral vertically above the lower infrapectoral and the second thoracic, situated obliquely above and anterior to the pectoral base, slightly nearer to the pectoral than the lateral line. Lower infrapectoral anterior to the upper and but little below it. Thoracics 5, the anterior two interspaces wider than the posterior two; the first pair nearest the median line, the fifth pair more widely separated, at base of outer ventral rays. Supraventral vertically over the fifth thoracic, or even slightly anterior to this line, its distance from lateral line about one-fourth its distance from base of ventrals. Ventrals four, the second elevated, vertically above the first, on a level with the second infrapectoral; the other three contiguous to the midventral line, the space between the first and third longer than that between third and fourth. Supra-anals 3, sharply angulated, the third on the lateral line, vertically above the first antero-anal, the second halfway between lateral line and base of first anal ray, the third horizontally in front of the second, very slightly above a line joining the second with the elevated ventral. In the distribution of the photophores, this species agrees with *M. fibulatum*, having the second ventral and the first two supra-anals in line, the supraventral far above them. In *M. pterotum*, the first two supra-anals and the supraventral are in line. Antero-anals 6, equidistant from the base of fin. Posterolateral single, on the lateral line, vertically above the second or third anal ray before the last. Postero-anals 5, the first above the base of the

last anal ray. Precaudals widely separated, the first at base of rudimentary caudal rays, the second obliquely above and behind it, on the lateral line. In the largest specimen, 30 mm. long (too badly mutilated to serve as the type), are two luminous spots on the under side of the caudal peduncle. In the type and numerous other smaller specimens, none are developed. Their presence in a specimen 30 mm. long (doubtless a female), indicates that it approaches maturity and that the species is a diminutive one.

General color dusky, as in related species, with little luster.

List of Stations.

4909.	31° 38′ 30″ N.,	129° 27′ 30″ E.	Intermediate net, 300 fathoms.
4920.	30° 34′ N.,	129° 22′ E.	Intermediate net, 300 fathoms.
5064.	35° 02′ 10″ N.,	138° 38′ E.	Intermediate net, 300 fathoms.
5084.	34° 00′ 00″ N.,	137° 49′ 40″ E.	Intermediate net, 918 fathoms.

These localities are along the southern coast, from the vicinity of Kagoshima to Suruga Gulf. It was also secured by Mr. Owston in Sagami Bay. The type is deposited in the U. S. National Museum.

12. **Myctophum valdiviæ** Brauer.

Myctophum valdiviæ Brauer, Zool. Anz., Vol. 28, 1904, p. 398, fig. 6. Atlantic and Indian Oceans.

A single badly injured specimen has the upper series of photophores arranged along the dorsal outline, a position unknown in any other species, and is hence identified with *M. valdiviæ*. It was taken at Station 4920, south of Kagoshima (30° 34′ N., 129° 22′ E.), in the open intermediate net down to 300 fathoms.

Genus Centrobranchus Fowler.

13. **Centrobranchus chœrocephalus** Fowler.

Centrobranchus chœrocephalus Fowler, Proc. Acad. Nat. Sci. Phila., Vol. 55, 1903 [1904], p. 754; Hawaiian Islands.

A single young specimen from Station 4921, south of Kagoshima (30° 23′ 30″ N., 129° 36′ 30″ E.). As usual in this species, the supra-anals are very obliquely arranged, the anterior of the series over the interspace between the second and third ventrals. There are 5 antero-anals and 9 postero-anals, a combination which did not occur in seventy-one specimens reported on previously from the Hawaiian Islands; but both numbers occurred there separately.

Genus Diaphus Eigenmann & Eigenmann.

Key to Japanese Species of Diaphus.

a. Pre-orbital photophore confined to a single minute dot above the nostril.
b. Upper supra-anal and the posterolateral immediately below the lateral line. . **D. agassizi.**
bb. Upper supra-anal and the posterolateral far below the lateral line..... **D. nipponensis.**
aa. Upper pre-orbitals on the front of the snout, directed forwards like headlights, occupying each a roundish depression above the nostril.
c. Accessory gland developed in connection with suprapectoral only.
d. Lower pre-orbital widely separated from the upper on lower anterior border of orbit, a minute detached subocular point usually present behind it. Pre-opercular border nearly vertical..... **D. nanus.**
dd. No lower detached pre-orbital, the upper continuous with a narrow strand along anterior border of orbit. Pre-opercular border oblique.
e. Third ventral elevated, in line with supraventral, second supra-anal and first antero-anal. Third precaudal midway between first and fourth, the last interspace much the widest..... **D. tanakæ.**
ee. Third ventral low, much below the line joining supraventral and second supra-anal. Last precaudal interspace little wider than the others. **D. sagamiensis.**
cc. Accessory glands developed in connection with all the photophores of the upper lateral series. No lower pre-orbital, a large suborbital..... **D. glandulifer.**
aaa. A narrow luminous bar on upper and one on lower orbital border, the latter continued as a very narrow strand around front of orbit..... **D. anteorbitalis.**
aaaa. Pre-orbital expanded to cover the entire snout..... **D. gigas.**
aaaaa. Pre-orbital not as above, narrow, occupying the anterior or anterior and inferior border of the orbit, without detached portion (the upper portion expanded above nostrils in *D. sagamiensis*).
f. Upper series of photophores well below the lateral line..... **D. cœruleus.**
ff. Upper series of photophores immediately below the lateral line.
g. Pre-orbital not continued along lower margin of orbit. First antero-anal greatly elevated, nearly vertically above the second..... **D. latus.**
gg. Pre-orbital continuous with a luminous strand which extends along the most of the inferior border of the orbit. First antero-anal not greatly elevated, above and anterior to the second..... **D. sagamiensis.**

14. **Diaphus agassizi** Gilbert.

Diaphus agassizii Gilbert, Mem. Mus. Comp. Zool., XXVI, 1908, p. 226, Pl. 2 (Marquesas Islands).

Several specimens, the largest 26 mm. long, from Suruga Bay, in open intermediate net at 300 fathoms.

In the figure of the type above cited, the suprapectoral should be higher, a little above the level of the supraventral, and somewhat nearer lateral line than base of pectoral. Also, the third ventral should be higher on side, on a

level with the second supra-anal, or a trifle above its level, and the third ventral, the second supra-anal, and the first antero-anal in a nearly straight horizontal line.

The anal photophores are 6 to 7 + 5 to 6 in the Japanese material, 6 + 6 and 7 + 5 being the prevailing combinations, 6 + 5 and 7 + 6 also occurring. The number 8 was not found in the anterior group, though this occurred in the type specimen. There are no traces of luminous areas around the eye, but the minute pre-orbital photophore above the nostril is present in all specimens. In this respect, the species agrees with *D. nocturnus* Poey (= *lacerta* Goode and Bean), but has no trace of the minute inferior photophore present in the latter within the lower anterior rim of the orbit (Gilbert, Bull. Mus. Comp. Zool., XLVI, 1906, p. 257, Pl. 1).

List of Stations.

4969.	33° 23′ 40″ N.,	135° 33′ 00″ E.	587 fathoms.
5058.	Suruga Bay.		Intermediate net, 300 fathoms.
5063.	Suruga Bay.		Intermediate net, 300 fathoms.
5064.	Suruga Bay.		Intermediate net, 300 fathoms.

15. **Diaphus nipponensis** sp. nov.

Type 21 mm. long, from Albatross Station 4920, south of Kagoshima (30° 34′ N., 129° 22′ E.), open intermediate net at 300 fathoms.

Very closely allied to *D. gemellari* (Cocco), differing in the lower position of the photophores of the upper series, the straight supra-anals (not angulated), and the position of the last antero-anal and first postero-anal, neither of which is elevated. In certain of these respects the species agrees with Brauer's figure of a specimen from Messina (Die Tiefsee Fische, 1908, p. 213, text-figure 131), but the latter differs in so many respects from typical *D. gemellari*, including contour of head, size of the dorsal fin, the position of the postero-lateral with reference to the adjacent spots of the anal series, and the position of the precaudals, that we are justified in doubting the identity of this specimen with *D. gemellari*.

Measurements in hundredths of length exclusive of caudal fin (16 mm.): Length of head 35; axial length of snout 6; diameter of eye 7; length of maxillary 27; greatest depth 28; least depth of caudal peduncle 13; distance from tip of snout to front of dorsal 47; to insertion of ventrals 46; to front of anal 63.

Dorsal rays 16; anal rays 14; pectoral rays 11 or 12; ventral rays 9. Scales of lateral line 36.

The shape of the head resembles that of *D. agassizi*, having a long snout protruding beyond the orbit for a distance nearly equaling the diameter of the latter and a long maxillary accompanied by an oblique pre-opercular margin The eye is very small and everywhere far from the profile.

The origin of the dorsal is somewhat in advance of the middle of the length (without caudal); posteriorly it overlaps the front of the anal. The adipose fin is inserted over the last anal rays.

Photophores.—A minute round pre-orbital on orbital rim above the level of the nostril as in *gemellari* and *agassizi*. Suprapectoral very low, above and in front of the pectoral, distant from it not farther than the width of the pectoral base, less than one-third its distance from lateral line. Upper infrapectoral in front of lower pectoral rays, not in contact with their base; lower infrapectoral slightly below the line joining the upper with the first thoracic, and a little nearer the upper. Fourth thoracic over middle of interspace between third and fifth, barely above the level of the base of the ventral fin; second thoracic midway between first and fifth, the second interspace the shortest; fifth thoracic not so far out as usual, in front of middle of ventral base. Supraventral over axil of ventrals, its distance from base of fin, half its distance from lateral line. Third ventrals barely above base of outer ventral ray, on a level with fourth thoracic and first supra-anal; fifth ventrals at sides of vent. Supra-anals in a very oblique straight line, which includes also the fifth ventral, the four spots equally spaced; third supra-anal but little in advance of the first anal, equidistant between it and the lateral line. Antero-anals 5, equally spaced, in a straight line, none of them elevated. Posterolateral single, directly over the interspace between the two anal series, resembling an elevated antero-anal and scarcely more distant from the last of that series than the antero-anals are from one another. Postero-anals 6, in a straight line, the anterior very slightly elevated on one side, not on the other. Anterior precaudals lying lower than the anal series, the four forming a very gentle nearly horizontal curve and all equally spaced; the fourth is twice as far from the lateral line as from the lower margin of the caudal fin.

Light brownish, the margins of the scales coarsely pigmented with darker, the sides of head and snout lighter.

Only the type known; deposited in the U. S. National Museum.

16. **Diaphus nanus** Gilbert.

Diaphus nanus Gilbert, Mem. Mus. Comp. Zool., XXVI, 1908, p. 224, Pl. 1. (Marquesas Islands.)

Several specimens off the southern coasts of Kiusiu and Hondo, taken in the intermediate nets operated at 300 fathoms and below. The largest individual is 45 mm. long, but answers well to the description and figure of the type, though this was very immature (17 mm. long). The photophores and the pre-orbital luminous organs do not vary in size or position with growth. The first antero-anal is not equally elevated with the second supra-anal as shown in the figure, but is constantly below the level of the latter. The lower pre-orbital varies extensively in different specimens, as in the closely related *D. theta*, being sometimes reduced to a small spot below the anterior margin of the pupil and sometimes developed so as to fill in the entire space between the eye, the front of the premaxillaries, and the nostril. A suborbital dot is usually present below the middle of the pupil. The anal photophores are usually 5 + 4 or 5 + 5 in number, occasionally 6 + 4 or 6 + 5, 3 in the posterior group on one side only in one specimen. In a few individuals, including several very immature and one of larger size, the first antero-anal is not elevated, but lies close to the base of the anterior anal rays. In all other respects, including the angulated supra-anals and the high position of the upper row of photophores, these agree with the other specimens, so we are clearly concerned with a question of individual variation.

List of Stations.

4920.	30° 34′ N.,	129° 22′ E	Intermediate net, 300 fathoms.
4951.	31° 10′ 30″ N.,	131° 58′ 30″ E.	Intermediate net, 300 fathoms.
4954.	32° 05′ N.,	133° 02′ E.	Intermediate net, 300 fathoms.
5063.	35° 01′ 10″ N.,	138° 38′ 50″ E.	Intermediate net, 300 fathoms.

17. **Diaphus tanakæ** sp. nov.

Type 21 mm. long, from Albatross Station 4951, off the southern coast of Kiusiu (31° 10′ 30″ N., 131° 58′ 30″ E.), intermediate net at 300 fathoms.

Very closely related to *D. nanus* Gilbert, but with the upper series of photophores somewhat higher, the third supra-anal vertically above the second or slightly in advance of it (well behind it in *D. nanus*), the posterolateral vertically above the last antero-anal (behind it in *D. nanus*), and the last pre-caudal interspace decidedly wider than those which precede (but little wider in *D. nanus*). The eye is smaller, the snout longer, the maxillary much longer, the pre-orbital luminous bodies are different in shape and in extent.

Measurements in hundredths of length without caudal (16 mm.): Length

of head 37; greatest depth 27; least depth of caudal peduncle 14; axial length of snout 5; diameter of eye 9; length of maxillary 24; distance from tip of snout to origin of dorsal 47; to insertion of ventrals 49; to front of anal 64.

Dorsal rays 15; anal rays 15; pectoral rays 11 or 12. Scales of lateral line 36.

Snout bluntly rounded, but protruding beyond the eye farther than in *D. nanus* and related species, its axial length somewhat greater than half the diameter of the eye. Maxillary long, extending beyond the orbit a distance equaling seven-ninths the diameter of the orbit, its posterior portion not widened; pre-opercular border oblique.

Pectorals reaching base of ventrals, the latter slightly overlapping front of anal. Insertion of ventrals behind the vertical of origin of dorsal; anal not overlapping the dorsal.

Photophores.—Pre-orbitals small roundish bodies immediately above the nostrils, directed forwards and little visible from the side; they are about as large as the nostrils and are widely separated mesially; from their lower outer border a very narrow luminous streak extends downwards around the anterior border of the eye, but not on its ventral aspect. The posterior outer border, both of the slender streak and of the rounded expansion above the nostril, is densely pigmented. No line of division can be detected between the two portions. No sub-ocular spot. Suprapectoral midway between lateral line and base of pectoral. Fourth thoracic above and a trifle behind the third, on the level of the middle of pectoral base. Second thoracics midway between first and fifth, the second and fourth interspaces nearly equal. Supraventrals slightly nearer base of ventrals than lateral line. Third ventral lower than supraventral, on a level with the second supra-anal. Upper supra-anal in contact with the lateral line, or a mere trifle below it, vertically above the second, which is above and a little behind the first; the first and second are very close, the space between them less than half that separating the second and third, and the first is still nearer the fifth ventral, which is before and a little below it. First antero-anal elevated, nearly as high as the second supra-anal, in an oblique line joining second antero-anal and upper supra-anal. Antero-anals 6, the second to the fifth in a straight line diverging from base of anal a little posteriorly, the sixth elevated, obliquely above and behind the fifth, the last interspace equal to those that precede. Posterolateral vertically above the sixth antero-anal, in contact with the lateral line. Postero-anals 5, all on the same level. Precaudals 4, the first three equally spaced, in a gentle curve following base of lower caudal lobe, the fourth more elevated, above and behind the third, very near the lateral line, the third equidistant from the first and the fourth.

Color dark brown, apparently deeper at base of caudal; cheeks, mandible and snout whitish in spirits, probably translucent in life.

Two small cotypes from the same station as the type and one from Station 4977, 33° 23′ N., 135° 37′ 40″ E., 544 fathoms, but probably taken nearer the surface. Type deposited in the U. S. National Museum.

Named for Shigeho Tanaka of the Imperial University at Tokyo, for his valuable contributions to the ichthyology of Japan.

18. **Diaphus glandulifer** sp. nov. (Plate XI, fig. 2.)

Type 58 mm. long without the caudal fin, from Station 5058, Suruga Gulf, taken with an intermediate net hauled at 300 fathoms.

Differing from all known species of the genus in the extensive development of the glandular organs of the photophores. In other species, only one is present, attached to the suprapectoral, while in the present species, glands are attached to all the photophores of the upper series and to the majority which are intermediate in position between the upper and the ventral series. A round pre-orbital above the nostril, directed forward, and a conspicuous suborbital under middle of eye. No inferior pre-orbital.

Measurements in hundredths of length to base of caudal: Length of head 32; diameter of eye 8; width over middle of orbits 9.5; length of snout 4; length of maxillary 23; oblique length of cheek 13; depth of body 21; depth of caudal peduncle 9; predorsal length 45; base of dorsal 19; preanal length 63; base of anal 18; length of pectorals 15; length of ventrals 23.

Dorsal rays 15 (including rudiments, the last ray cleft to base); anal rays 15 (last ray cleft to base); pectoral rays 12 or 13; ventral rays 8. Scales of lateral line 34.

Snout short, bluntly and evenly rounded; pre-opercular margin oblique, the maxillary scarcely widened posteriorly, almost reaching pre-opercular margin, twice as long as snout and orbit. Gill-rakers 10 + 19, the longest six hundredths of the total length without caudal. Origin of dorsal over base of ventrals, its last ray above the vent. Adipose fin over last anal ray. Pectorals short, barely attaining the base of the ventrals, which pass the origin of the anal.

Photophores.—A roundish pre-orbital in a pit of the dorsal side of the nostril, extending mesad nearly to the median crest; lower pre-orbital wanting. Sub-orbital very sharply defined, invariable in shape and position; it is large, roundish in outline, encroaches on lower part of eyeball, and lies in or slightly behind its vertical diameter. It evidently corresponds to the detached point

from the inferior preorbital in *D. rafinesquei, theta,* and *nanus,* and is developed in specimens 12 mm. long. The anterior and inferior orbital margins densely black. Suprapectoral low, midway between upper pectoral ray and lateral line. First pair of thoracics nearest the median line, second and third pairs equidistant from it, fifth pair separated by more than twice the distance separating the third pair; fourth thoracic elevated but little above the ventral base, a little behind the vertical from the third thoracic. Supraventral high, its distance from lateral line two-fifths the distance from base of ventrals. Second and third ventrals unusually high, the third on middle of area below lateral line, a little below the line joining the first and second, and slightly in advance of the vertical from the fourth. First supra-anal at the side of the vent, in line with the first, fourth and fifth ventrals and apparently forming one of the ventral series. Line of the supra-anals slightly angulated, the second in advance of the line joining first and third. Third supra-anal not in contact with the lateral line, but under the lower part of its 18th scale. Antero-anals 6, the first and last elevated, the others in a straight line parallel to anal base, the first about on level of middle supra-anal, in a line joining upper supra-anal and second antero-anal; the last slightly behind the line joining the fifth antero-anal and the posterolateral, equidistant from both. Posterolateral immediately below the lateral line. Postero-anals 5. Precaudals 4, the first two placed horizontally and lying deeper than the postero-anals, the third a little elevated and more widely spaced, the fourth much more widely spaced, near the lateral line, and but little behind the third.

Glandular bodies are always connected with the suprapectoral, supra-anal, the posterolateral, and the upper precaudal; usually also with both infrapectorals, the fourth thoracic and the second and third ventrals; occasionally with the first antero-anal and the third precaudal.

General color blackish, with metallic bluish reflections.

A number of cotypes from the following Stations, and also from Sagami Bay (C. M. No. 4606). The type is deposited in the U. S. National Museum.

List of Stations.

4926.	Colnett Strait, south of Kagoshima	Intermediate net, 300 fathoms.
5058.	Suruga Bay.	Intermediate net, 300 fathoms.
5063.	Suruga Bay.	Intermediate net, 300 fathoms.
5064.	Suruga Bay.	Intermediate net, 300 fathoms.
5084.	Suruga Bay.	Intermediate net, 300 fathoms.

19. **Diaphus anteorbitalis** sp. nov. (Plate XII, fig. 1.)

Type 93 mm. long to base of caudal, from Station 4968, off Shiwo Misako (33° 24′ 50″ N., 135° 38′ 40″ E.), depth 253 fathoms.

Very closely allied to *D. adenomus* Gilbert from the Hawaiian Islands, differing only in the greater development of the circumocular luminous bodies, in the slightly higher position of the suprapectoral photophore, and in the larger eye.

Measurements in hundredths of total length to base of caudal: Length of head 28.5; diameter of eye 7.5; interorbital width above middle of eye 9; length of snout 5; of maxillary 22; greatest depth of body 22; least depth of caudal peduncle 11; distance from tip of snout to front of dorsal 43; to base of outer ventral ray 43; to base of last dorsal ray 60; to front of anal 64; to last anal ray 81; to adipose fin 80; length of base of anal fin 18; of dorsal fin 19.

Dorsal rays 15 (3 rudiments; last ray cleft to base); anal rays 15 (2 rudiments); pectoral rays 12; ventral rays 9, the outer ray short, rudimentary. Scales of lateral line 36, the third supra-anal photophore on the 18th scale, the posterolateral on the 25th. Gill-rakers 5 + 11.

Diameter of eye about one-fourth length of head (about one-fifth head in *D. adenomus*). Origin of dorsal and base of outer ventral ray in the same vertical; last dorsal ray over the vent; last anal ray under the adipose fin. Pectoral reaching a point halfway between fourth thoracic photophore and base of ventral. Longest ventral ray reaching to or nearly to the vent.

A well-developed supra-orbital luminous body, as in *D. adenomus*, found only in these two species. It is in the form of a narrow streak along the upper border of the orbit, not extending behind the pupil; a small superior pre-orbital, in its usual position above the nostril; a third luminous body occupies the position of both suborbital and inferior pre-orbital, extending on the inferior border of the eye to or beyond the middle of the orbit, becoming abruptly narrowed beneath front of eye and sending a narrow upward extension nearly to the level of the superior pre-orbital. In *D. adenomus*, both the superior pre-orbital and the extension between eye and nostril are lacking. Suprapectoral photophore above the angle of the opercular flap, slightly nearer base of pectoral than lateral line, accompanied below by a small glandular body. Fourth thoracic and third ventral low, but little above the level of the ventral base. Supraventral midway between the lateral line and the ventral base, or a trifle nearer the lateral line. Supra-anals in a nearly straight line, the middle spot slightly behind the line which joins the other two and passes just caudad

of the fifth ventral. Upper supra-anal immediately below the lateral line, the posterolateral and the upper precaudal slightly below its level. Antero-anals about equally spaced, the first above and anterior to the second, less elevated than the middle supra-anal. Last antero-anal elevated, nearly midway between its predecessor and the posterolateral, but a trifle behind the line joining the two. The remaining four posteroanals form a gently curved line which rises slightly posteriorly. Postero-anals five (six in one cotype). Precaudals forming a gently curved line nearly parallel with base of lower caudal lobe, the upper spots more widely spaced than the lower two.

General color dusky; lining of mouth and gill cavity black, the opercle with blue-black reflections. A black area above each eye. A dusky band across the mandible below eye. Fins with minute dark specks.

Three cotypes from the same locality as the type; the latter is deposited in the U. S. National Museum.

20. **Diaphus gigas** sp. nov. (Plate XII, fig. 2.)

Type 172 mm. in total length, 140 mm. to base of caudal, from Sagami Bay; collection of Alan Owston (C. M. No. 4601).

Most nearly related to *D. chrysorhynchus* Gilbert and Cramer and *D. perspicillatus* Ogilby. From both species it differs in the greater development of the inferior pre-orbital, which is produced dorsally well beyond the small triangular superior pre-orbital. It differs further from *D. perspicillatus* in the lower position of the third ventral photophore, and from *D. chrysorhynchus* in the lower suprapectoral and in the restriction of the inferior pre-orbital to the portion of the lower orbital rim in advance of the pupil. In *D. chrysorhynchus*, it extends to below the posterior margin of the pupil.

Brauer's description and figure of *D. elucens* (Die Tiefsee Fische, pp. 219, 220), fails to indicate any difference from *D. perspicillatus*, with which it is probably identical.

Measurements in hundredths of length without caudal: Length of head 29; diameter of eye 8.5; length of snout 3.8; frontal width at middle of eyes 10; length of maxillary 19.5; distance from eye to end of maxillary 11; depth of body 20; of caudal peduncle 8.5; distance from tip of snout to front of dorsal 42; to base of ventrals 43.5; to last dorsal ray 62.5; to front of anal 63.5; to last anal ray 81; to adipose dorsal 80. Length of pectorals 13; of ventrals 18.

Dorsal rays 15 (2 rudiments); anal rays 15 (2 rudiments); ventral rays 9 (1 rudiment); pectoral rays 11. Scales of lateral line 35, the upper supra-anal on the 18th scale, the posterolateral on the 25th. Gill-rakers long, 8 + 16.

As in related species, the eye is large, the snout very short and high, bluntly rounded. Preopercular margin only moderately oblique, the maxillary reaching its anterior border. Pectoral not quite reaching base of ventrals, the latter attaining the vent. Dorsal beginning slightly in advance of base of ventrals, the anal a little behind last dorsal ary, the adipose fin above the last anal ray. Scales of lateral line not enlarged, their vertical diameter nowhere exceeding their distance from middorsal line.

Photophores.—Superior pre-orbital smaller than in *D. chrysorhynchus*, oval in shape, the massive inferior pre-orbital expanding above the nostril, occupying all the area between the smaller pre-orbital and the median crest, and continued much beyond it dorsally; ventrally, the inferior pre-orbital ceases abruptly opposite the pupil or in front of this point. No trace of an infra-orbital. Distance from suprapectoral to lateral line 1.2 in its distance from base of ventrals (1.66 in *D. chrysorhynchus*). Fourth thoracic on level of base of ventrals, the third ventral only a trifle higher, much below the level of the supraventral, which is over the axil of the ventral and is nearer ventral base than lateral line. Third supra-anal immediately below lateral line, the three of the series in an oblique line, not angulated, the lowermost opposite the vent, above and behind the fifth ventral. First antero-anal elevated, not so high as middle supra-anal, in a line joining the upper supra-anal and second antero-anal. Second to fifth antero-anals form a slightly curved line which gently rises, the sixth more elevated. Postero-anals 5. Posterolateral but little below the lateral line, a trifle farther removed than the upper supra-anal. Precaudals forming a broad curve; the first two slightly less separated than the other two, the uppermost not so near the lateral line as the posterolateral.

Color very dark. A broad dark bar across mandibles below eyes; mouth and gill-cavity black.

Two cotypes from Sagami Bay, the largest 21 cm. (C. M. No. 4602). The type is deposited in the Carnegie Museum.

21. **Diaphus cœruleus** (Klunzinger).

Scopelus cærulcus Klunzinger, Verh. k. k. zool. bot. Ges. Wien., Vol. 21, 1871, p. 152. (Indian Ocean.)

Diaphus watasei Jordan and Starks, Bull. U. S. Fish Com. for 1902 [1904], p. 580. (Sagami Bay.)

Scopelus engraulis Günther, Deep Sea Fishes Challenger, 1887, p. 197, Pl. LI, fig. C. (Philippine Islands.)

Several specimens from Sagami Bay (C. M. No. 4603) were obtained from Mr. Alan Owston, and have been compared with the cotypes of *D. watasei* from the same locality. There seems no reason to doubt the identity of this material with *D. cæruleus* from the Indian Ocean. *D. engraulis* from the Philippines agrees in all respects except the smaller eye (said to be one-fifth the length of the head) but the figure shows it larger than this, and probably no difference exists.

22. **Diaphus latus** sp. nov. (Plate XIII, fig. 1.)

Type 75 mm. in total length, 64 mm. to base of caudal, from Sagami Bay; collection of Alan Owston (C. M. No. 4604).

Most nearly related to *D. splendidus, signatus,* and *sagamiensis,* but with deeper body, smaller eye, the pre-orbital restricted to the anterior border of the eye, the suprapectoral higher, the third supra-anal and the posterolateral in contact with the lateral line, the fourth precaudal immediately below it; the first antero-anal greatly elevated, nearly vertically above the second, the second to fifth antero-anals in a straight line, parallel with anal base.

Measurements in hundredths of length without caudal: Length of head 25; diameter of eye 5.5; length of snout 4; width over middle of orbit 7; length of maxillary 18; depth of body 23; of caudal peduncle 10; distance from tip of snout to dorsal 39; to base of ventrals 41; to front of anal 60; to adipose 76. Length of pectoral 11.5; of ventral 18.

Dorsal rays 15, including 3 rudiments, the posterior ray split to base; anal rays 16, including two rudiments; pectoral rays 12; ventral rays 9, the outer a short rudiment. Scales of lateral line 37, the upper supra-anal on the 18th scale, the posterolateral on the 26th or 27th. Gill-rakers long and slender, 7 + 15 (in cotype).

Body deeper than in related species; eye small, the profile rising well above its dorsal border; snout short, bluntly rounded; preopercular margin oblique, the maxillary reaching its margin. Pectoral short, not reaching base of ventrals, the latter not beyond the vent. Base of ventrals under or slightly behind the origin of dorsal; origin of anal slightly behind vertical from last dorsal ray, the last anal ray beneath the adipose.

Scales of lateral line not enlarged, their vertical diameter nowhere greater than their distance from mid-dorsal line.

Photophores.—Upper pre-orbital a small ocellated dot under the edge of the frontal, as in *D. signatus* and *D. agassizi;* lower pre-orbital occupying the area

between eye and nostril, expanding a little above the nostril, scarcely extending on the ventral aspect of the orbit; no trace of a suborbital. Suprapectoral immediately above angle of opercular flap, its distance from lateral line two-thirds its distance from base of upper pectoral ray (slightly lower in a cotype); the usual glandular body is attached to it below. None of the pectoral organs are concealed beneath the opercular flap. Fourth thoracic a trifle above the level of the ventral base, nearly vertically above the third thoracic. Supra-ventral nearer lateral line than base of ventrals. Third ventral not greatly elevated, a little below the oblique line joining first and second, not as high as the middle supra-anal. Supra-anals slightly angulated, the second a little in advance of the line joining the other two; the upper one is below the lateral line and in contact with it, the lower above and slightly behind the fifth ventral. First antero-anal greatly elevated, nearly vertically above the second, on a level with middle supra-anal, its distance from second much greater than that between second and third, and equaling that between third and fifth. Second to sixth antero-anals in a straight line, parallel with anal base, the seventh elevated, the line joining sixth and seventh passing just behind the posterolateral, which is in contact with the lateral line. Postero-anals 5. Last precaudal a little below the end of the lateral line, the first two horizontal, at lower edge of tail, the third a little above them.

General color very dark, the mouth and gill-cavity black; vertical fins with the rays black-dotted. . The anals vary from 6 to 7 + 5 to 6.

Several cotypes from Sagami Bay (C. M. No. 4605). The type is deposited in the Carnegie Museum.

23. **Diaphus sagamiensis** sp. nov. (Plate XIII, fig. 2.)

Type 67 mm. in total length, 53 mm. to base of caudal, from Sagami Bay, Japan, collection of Alan Owston (C. M. No. 4608).

Most nearly related to *D. signatus* Gilbert, but with the lower pre-orbital extending along the ventral border of the orbit to vertical from posterior border of pupil, the supraventral photophore midway between lateral line and base of ventrals (decidedly nearer lateral line in *D. signatus*), the first antero-anal less elevated, the second much less widely spaced from third, and the precaudals less widely spaced, the fourth lower. The photophores are larger, and the form deeper. It differs also from *D. cæruleus* and *D. splendidus*, in the ventral continuation of the lower pre-orbital, and in details of position and spacing of the photophores.

Measurements in hundredths of length without the caudal fin: Length of head 28; diameter of eye 8; length of snout 4.5; length of maxillary 20; greatest depth of body 21; least depth of caudal peduncle 9; distance from tip of snout to front of dorsal 42; to insertion of ventrals 43; to front of anal 61; to adipose fin 75. Length of pectorals 11.5; of ventrals 16.

Dorsal rays 17 (including anterior rudiments); anal rays 15; pectoral rays 12; ventrals rays 9, the outer reduced to a short rudiment. Scales of lateral line 35, the upper supra-anal on the 18th scale, the posterolateral on the 25th. In a cotype, the upper supra-anal is on the 19th scale, the posterolateral on the 27th.

Snout very short, bluntly rounded, its length slightly exceeding half the diameter of the eye; pre-opercle only moderately oblique, the maxillary reaching its margin. Gill-rakers 8 + 17, more numerous than in *D. signatus*.

Pectorals short, not reaching ventrals, the ventrals not reaching beyond the vent, inserted under the front of dorsal. Last dorsal ray over or slightly behind origin of anal; last anal ray under the adipose. Scales all fallen. General color blackish; no dark bars evident on mandible.

Photophores.—Upper pre-orbital small, triangular, on the orbital margin, not constricted off from the broader mass of the lower pre-orbital, which fills the area on the dorsal side of the nostril, narrows between the nostril and the eye and continues without interruption on ventral side of orbit to or beyond vertical from posterior margin of pupil. Dorsally, the upper pre-orbital interposes between it and the eye, and mesially it is well separated from its fellow. It differs from the pre-orbital slightly in color and appearance, and does not in the lower part of its course give any evidence of union with a suborbital organ.

Suprapectoral high, its distance from lateral line but half its distance from pectoral base; attached to it a very small inconspicuous glandular organ. Fourth thoracic opposite to or very slightly above the base of ventrals. Supra-ventral midway between lateral line and base of ventral (in cotypes, a little nearer ventral). The line joining first and second ventrals passes above the third ventral, which is but little above the level of the base of the outer ventral ray. Supra-anals in a straight line, or the second slightly in advance, the first opposite the vent, above and behind the fifth ventral, the third in contact with the lateral line, vertically above the first anal ray. Antero-anals about equally spaced, the first much less elevated than in *D. signatus*, the line joining first and second passes below the upper supra-anal. All antero-anals except the first form a gently and regularly curved line rising posteriorly, the last sometimes a trifle

more elevated. Antero-anals normally 6 in number, the postero-anals 5; in one cotype the number is 7 + 4. Posterolateral immediately below lateral line, scarcely in contact with it. Precaudals in a gentle obliquely disposed curve, the first two more closely set than are the postero-anals, the last two a little more widely spaced; fourth precaudal well below end of lateral line.

Five cotypes from the same locality as the type (C. M. No. 4609), and one from Albatross Station 5064, Suruga Bay, taken with open intermediate net at 300 fathoms.

Type deposited in the Carnegie Museum.

Genus Lampanyctus Cocco.

Key to Japanese Species of Lampanyctus.

a. Luminous scales not confined to the precaudal region.

b. Dorsal and anal short, about equal in length. Only one photophore above the base of pectoral fin. Supra-anals in an oblique line.....**L. townsendi.**

bb. Dorsal and anal long, much overlapping, the dorsal the longest. Two pectoral photophores above the base of the pectoral fin. Supra-anals angulated. Two posterolaterals, on a level.....**L. japonicus.**

aa. Luminous scales confined to precaudal patches, or with one in addition in front of adipose fin.

c. Supra-anals in an oblique line.....**L. leucopsarum.**

cc. Supra-anals angulated.

d. Pectorals short, not reaching base of ventrals.

e. Last precaudal vertically above the one preceding.....**L. niger.**

ee. Last precaudal above and behind the preceding.....**L. microchir.**

dd. Pectorals longer, extending well beyond base of ventrals.

f. A spot on the cheek and one on shoulder. Numerous accessory dots scattered over head and body.

g. Second and third antero-anals not elevated.....**L. punctatissimus.**

gg. Second and third antero-anals elevated, on the same level. **L.jordani.**

ff. A spot on the shoulder, none on the cheek.....**L. macropterus.**

24. **Lampanyctus townsendi** Eigenmann and Eigenmann.

Lampanyctus townsendi Eigenmann and Eigenmann, West American Scientist, 1889, p. 125, from Cortez Banks, near San Diego, Cal. Gilbert, Mem. Mus. Comp. Zool., XXVI, 1908, p. 230, Pl. 4. (Marquesas Islands, Pacific Ocean.)

Three specimens, the largest 60 mm. long, taken off southern Japan. In life the species is almost jet-black, and probably lives at a considerable depth. One of the specimens was taken in a bottom trawl at 507 fathoms; the other two in an intermediate net operated at 850 fathoms. In both cases, they may of course have entered the net nearer the surface.

As previously indicated, this species is nearest *L. warmingi* Lütken, which has been reported from the Indian Ocean and the eastern part of the Atlantic. *L. townsendi* is readily distinguished from *L. warmingi* in the presence of 5 ventral photophores instead of 4. Also the fifth thoracic is elevated, on the level of the outer ventral rays, the supraventral is low, midway between lateral line and base of ventrals. In other respects, they seem very similar. The ventral photophores in *L. townsendi* are arranged much as in *L. maderensis*, the first pair closely approximated on the same level, which is about that of outer ventral ray, the fourth pair much more closely apposed, and the fifth pair again diverging at the sides of the vent and a little anterior to it. Additional points can be made out on these specimens concerning the distribution of the luminous scales. A short patch of five scales on back of caudal peduncle involves the rudimentary caudal rays; a long band covers all of inferior surface of caudal peduncle and contains twelve or thirteen scales; a series along each side of base of anal fin; a median series from base of ventrals to vent, and a pair at sides of vent; a median scale somewhat in advance of ventrals; a median scale on isthmus and two on each side forming with it lines diverging backwards towards bases of pectorals. As the skin is lost in front of the dorsal fin, no trace of luminous scales can there be found.

The figure of *L. townsendi* above cited, based on a very small specimen from the Marquesas Islands, represents the snout very much sharper than in the Japanese specimens, wherein it is rather heavy and bluntly rounded. No material is at hand for comparison.

List of Stations.

4954. 32° 05′ N., 133° 02′ E. Intermediate net, 850 fathoms.
4980. 34° 09′ N., 137° 55′ E. 507 fathoms.

25. **Lampanyctus japonicus** (Tanaka).

Macrostoma quercinum japonicum Tanaka, Journ. Coll. Sci. Imp. Univ., 1908, p. 5, Pl. 1, fig. 3.

No additional material has been secured and the type has not been examined. Tanaka was unable to point out any differences between the Japanese species and *L. elongatus* (= *L. quercinus*) from the Atlantic, and the specific name is here retained awaiting an opportunity to make direct comparison of material from the two oceans. It is apparent that the number of photophores in Tanaka's figure is not entirely reliable. Apparently fragments of luminous

scales have been mistaken for photophores in some instances. Thus the lower of the pectoral series, two in the thoracic series and one of the supraventrals belong in this category and are redundant. If the number of gill-rakers is correctly given as 9 + 13, this may serve to distinguish this species, as in several specimens of *L. elongatus* from the Atlantic, there are constantly eighteen to twenty rakers on the anterior portion of the outer arch.

26. **Lampanyctus nannochir** (Gilbert).

Myctophum nannochir Gilbert, Proc. U. S. Nat. Mus., XIII, p. 51; Pacific coast, U. S.

A single specimen was secured at Albatross Station 5030, in the southern part of the Okhotsk Sea, southeast of Cape Patience, Sagalin; hitherto unrecorded in the western Pacific south of Bering Sea. The specimen has all the characters which serve to distinguish this form from *L. leucopsarum;* the larger photophores, the smaller number of luminous scales on caudal peduncle, the somewhat lower position of the upper series of photophores on the sides, and the presence of three instead of four precaudals. Occasionally a specimen of *L. nannochir* has a fourth precaudal on one side, but no case has come under our notice in which *L. leucopsarum* has but three precaudals. In addition to these characters, it was ascertained during the cruise of 1906 that in life the photophores of *nannochir* are constantly a bright ruby-red, whereas in *leucopsarum* they are golden-yellow. No trace of this difference persists in preserved material. The two species are extremely closely related; occasionally a young specimen is difficult to determine. Furthermore, they accompany each other throughout their range. But a number of minor characters have thus far shown a constant correlation which makes it impossible to ignore them.

27. **Lampanyctus niger** (Günther).

Nannobrachium nigrum Günther, Deep Sea Fishes Challenger, 1887, p. 199, Pl. LII, fig. B.

A single specimen 71 mm. long, from Albatross Station 4958, in the Bungo Channel, depth 405 fathoms. The present status of the species is very unsatisfactory, as the original description and figure have no reliable indication of the distribution of the photophores. Our specimen is much slenderer than is indicated in the figure by Brauer (Die Tiefseefische, 1906, p. 242, fig. 159), agreeing in this respect and in general appearance with Günther's figure above cited. The position of the photophores agrees in most details with that shown by Brauer.

The suprapectoral is on the lateral line, the upper infrapectoral on a level with it and a trifle posterior. Fourth thoracic elevated, on level of middle of pectoral fin. Ventrals 4, the second a very little farther out at the side than the others, the fourth at sides of vent. Supraventral, third supra-anal, and posterolateral immediately below lateral line, the last precaudal on or above the lateral line. Supra-anals forming a very blunt angle, the third vertically above the first antero-anal, the second above the vent, the first just anterior to the third ventral; first and second on the same level, which is also that of the fourth thoracic. Antero-anals 7, their line not arched, the first two more widely spaced than the others, the last one elevated as usual. Postero-anals 8, continuous with the precaudals, the latter more widely spaced. Anterior 3 precaudals in a gentle curve at base of lower caudal lobe and evenly spaced, the fourth much more widely separated, above and slightly anterior to the third, on or a little above the lateral line.

The pectoral is injured, but was evidently short, and consisted of extremely delicate rays which are however more numerous than represented by Günther, being twelve or fourteen in number.

The color was black, the body is much slenderer than is represented by Brauer (l. c., p. 242, fig. 159), the depth a trifle less than one-fifth the length. The precaudals are also differently arranged, there being three instead of two along the base of the lower caudal lobe, and a fourth on lateral line, above and slightly anterior to the third. It may be that Brauer's figure is not entirely reliable, but the doubt he expresses concerning the identity of his specimens with Günther's species must also hold with the one here reported from Japan.

The three specimens previously reported from the Hawaiian Islands (Gilbert, Bull. U. S. Fish Com. for 1903 [1905], Part 2, p. 591) belong to this species. In the description, by error, four pectoral photophores are described, and the pectorals are said to contain but few (three to six) rays. A more careful examination shows the pectoral to contain about twelve excessively slender rays.

28. **Lampanyctus microchir** sp. nov.

Type 22 mm. in total length, 18 mm. to base of caudal; from Albatross Station 5064, Suruga Bay, intermediate net at 300 fathoms.

Very closely allied to *L. micropterus* Brauer, differing in the following details in the arrangement of the photophores:

1. Suprapectoral on the lateral line, instead of a short distance below it.

2. Fourth thoracic slightly below level of pectoral, instead of above its level.

3. Second ventral above and somewhat anterior to the first, instead of above and behind it.

4. First supra-anal on level of second, over or before the fourth ventral. In *L. micropterus*, the first supra-anal is considerably below the level of the second, and behind the fourth ventral.

Brauer compares *L. micropterus* with *L. oculeus* Garman, with which species he at first identified it. But the two are not closely related. *L. oculeus* has not only the infrapectorals obliquely arranged, but has both second and third ventrals elevated.

Measurements in hundredths of length without caudal: Length of head 33; diameter of eye 5.5; length of maxillary 23; greatest depth 21; least depth of caudal peduncle 6; distance from tip of snout to front of dorsal 53; to base of ventrals 46; to front of anal 56; to last dorsal ray 65; to last anal ray 75.

Dorsal rays 14; anal rays 17; pectoral rays 9; ventral rays 8. Scales of lateral line 34.

Ventrals inserted in advance of dorsal; origin of anal under middle of dorsal; pectorals very short and slender, not reaching ventrals; ventrals to vent.

Photophores.—A small pre-orbital on orbital margin immediately below level of posterior nostril; a small round spot on shoulder cannot be positively identified as a photophore; suprapectoral on the lateral line; upper infrapectoral in front of middle of pectoral base, the lower vertically below it. Thoracics five, the fourth elevated, vertically above the third and on level of lower pectoral ray; first thoracic interspace much wider than the others. Supraventral on the lateral line, somewhat in advance of the base on the ventral fins. Ventrals five, the second elevated, above and in advance of the first, the first, third, fourth and fifth equally spaced and equidistant from the midventral line. Supra-anals forming a right angle, the third on the lateral line under the middle of the dorsal fin, the second and first equally elevated, the second over or slightly in advance of the fourth ventral. Postero-anal on the lateral line. Antero-anals six, the fifth elevated, the others on the same level, the first interspace longer than those which follow. Posteroanals six, none of them opposite the anal fin. Precaudals three, the first above the first caudal ray, lower than the last postero-anal and separated from it by a wider space than occurs between the postero-anals; second precaudal elevated, a little behind the oblique line joining first and third, its distance from first little more than half its distance from the third, which is above and a little behind it, in contact with the lateral line.

Luminous scales confined to the caudal peduncle, three on the dorsal side, four ventrally. No minute accessory photophores.

Only the type known; deposited in the U. S. National Museum.

29. **Lampanyctus punctatissimus** sp. nov.

Type 20 mm. long to base of caudal fin, which is mutilated, so the total length cannot be ascertained. Albatross Station 5064, Suruga Bay, Japan, intermediate net at 300 fathoms.

Closely allied to *L. alatus,* differing in the presence of a spot on shoulder and a luminous scale before the adipose, and in the shorter pectoral fin.

Measurements in hundredths of length without caudal fin: Length of head 32; diameter of eye 5; length of snout 5; length of maxillary 24; depth of body 20; least depth of caudal peduncle 7; distance from tip of snout to front of dorsal 48; to front of ventrals 46; to front of anal 60; to last dorsal ray 62.

Dorsal rays 12; anal rays 17; pectoral rays 12; ventral rays 8. Scales of lateral line 34.

Snout short, but not rounded; a depression over front of eyes; middle of maxillary under posterior border of eye.

Origin of dorsal behind base of ventrals, its last ray about over the fifth of the anal. Pectoral more or less mutilated in all our specimens, but apparently not extending much if any beyond the front of the anal.

Photophores.—A well-developed spot on middle of cheek and one somewhat smaller on the shoulder. Suprapectoral very near the lateral line; upper infrapectoral somewhat above the middle of the pectoral base, the lower infrapectoral below and behind it in a line joining the upper infrapectoral and the second thoracic. Thoracics five, the fourth elevated, over the space between the third and fifth, on a level with middle of pectoral base. The second thoracics are about midway between the first and fifth pairs, the third nearer the second than the fifth. The second and third pairs are but little farther from mid-ventral line than the first pair, but the fifth are out at the sides in front of the outer ventral rays. The supraventral, upper supra-anal, posterolateral and upper precaudal are equally elevated and are near the lateral line but not in contact with it. Ventrals four, none of them elevated. Supra-anals forming a right angle, the anterior somewhat more elevated than the middle one, over the interspace between the second and third ventrals. Antero-anals seven, the posterior elevated, the first six on the same level. Postero-anals continuous with the precaudals, but a slight widening of the spacing seems to indicate that the precaudals are four in

number, the postero-anals six. The first two precaudals are in line with the postero-anals, the third a little elevated, the fourth near the lateral line,above and slightly in advance of the third.

Three luminous scales in front of lower caudal lobe, two in front of the upper; a single luminous scale in front of adipose fin.

In addition to the larger photophores, the head and body are thickly set with smaller luminous dots, which are surrounded with black pigment-rings and show a more or less definite arrangement. A well-defined series of about fifteen occur equally spaced along outer surface of mandible, and a similar series is on the maxillary. On sides of head and body, there is one to each scale, arranged under the tip of the exposed portion, as in *L. jordani*. A few extend out on the base of the caudal fin.

The general color is blackish brown.

The type is deposited in the U. S. National Museum.

List of Stations.

4969.	33° 23′ 40″ N., 135° 33′ E.	Intermediate 300 fathoms.
5058.	Suruga Bay	Intermediate 300 fathoms.
5064.	Suruga Bay	Intermediate 300 fathoms.

30. **Lampanyctus jordani** sp. nov. (Plate XIV.)

Type 121 mm. long to base of caudal, from Nemuro, Hokkaido, Japan (C. M. No. 4617), obtained in 1900 by Dr. Jordan.

Most closely related of *L. macropterus* Brauer, but the second and third antero-anals equally elevated, well above the level of the remainder of the series. A spot on the shoulder and one on the cheek. Four ventral photophores, none of them distinctly elevated. Luminous scales confined to the caudal peduncle and the front of the adipose fin. Dorsal fin shorter than the anal.

Measurements in hundredths of length without caudal fin: Length of head 27 (in cotypes 28); diameter of eye 6; length of snout 4.5; frontal width opposite middle of orbit 8; length of maxillary 20; depth of body 23; depth of caudal peduncle 12; distance from tip of snout to origin of dorsal 47; to base of ventrals 44; to last dorsal ray 60; to first anal ray 59; to last anal ray 80; to front of adipose dorsal 81; length of pectoral 23; of ventral 16.

Dorsal rays 13 (including 2 rudiments); anal rays 18 (2 rudiments); pectoral rays 15; ventral rays 9 (outer ray rudimentary). Scales of lateral line 40.

Mandible strongly upcurved towards symphysis, protruding beyond the

premaxillaries, reaching far beyond the eye. Dorsal origin distinctly behind insertion of ventrals, in advance of the middle of the body. Last ray of dorsal opposite or slightly behind the first of the anal. Last anal ray under the adipose dorsal. Pectorals long, reaching in the cotypes to or nearly to the vent; ventrals reaching front of anal.

Photophores.—Reniform in shape in uninjured specimens, those of the upper series most strongly marked in this respect. A minute pre-orbital slightly below the line joining the eye and nostril. One on cheek, in contact with upper border of maxillary. A small distinct spot constantly present on the shoulder, and another not represented in any other species, above and slightly behind the base of upper pectoral ray. Suprapectoral near lateral line, but distinctly below it. Upper infrapectoral in front of pectoral base above its middle, the lower infrapectoral below and behind it. Thoracics five, the fourth much elevated, on level of base of pectoral, the first pair nearer the median line than the second and third, the fourth farther apart on level of outer ventral ray. Distance between the first and second pairs greater than between the second and third, or between the third and fifth. Supraventral, upper supra-anal, posterolateral, and upper precaudal immediately beneath the tubes of the lateral line. Ventrals four, the first pair opposite the inner ventral rays, the second farther out at the side, but not distinctly elevated, on level of outer ventral rays, the third and fourth forming with the second a straight line, which slightly approaches the midventral line posteriorly. The four pairs are about equally spaced. First and second supra-anals on the same level, the first over the second ventral, the second over the fourth ventral. Antero-anals eight, the second and third elevated, on the same level, the eighth also elevated, slightly nearer the seventh than the posterolateral. Postero-anals eight or nine. Precaudals four, the lower three in a curved line at base of lower caudal lobe, the fourth more widely separated, on the lateral line. In the type, the first precaudal is a trifle lower than the last postero-anal and less definitely set off from that series than in the cotypes, where it is not only lower, but more widely spaced.

In addition to these larger photophores, there are numerous minute luminous dots on sides of head and on body, one of these on each scale of trunk, at the tip of its exposed portion.

Luminous scales: two in front of upper and nine in front of lower caudal lobe; two or three, with occasional traces of one or two more, in front of adipose fin.

General color dark brown or blackish, the fins a little lighter. The type is an old specimen bleached in the light. It was much darker in life than the figure indicates.

Two cotypes were secured at Albatross Station 5039, off the southern shore of Hokkaido (42° 11′ N., 141° 57′ E.); depth at bottom 269 to 326 fathoms. Type deposited in the Carnegie Museum.

Named for David Starr Jordan in appreciation of his epoch-making researches on the fish-fauna of Japan.

31. **Lampanyctus macropterus** (Brauer).

Myctophum (*Lampanyctus*) *macropterum* Brauer, Zoöl. Anz., 1904, p. 404, fig. 5; Indian Ocean.

A single specimen, 105 mm. long, was secured by the Albatross at Station 4951, near Kagoshima (31° 10′ 30″ N., 131° 58′ 30″ E.). The dredge was sent down in 703 fathoms, but evidently failed to reach the bottom as the contents were all deep pelagic, the failure obviously due to the swift currents of the Kurosiwo.

The specimen is larger than any of Brauer's types from the Indian Ocean, and differs from his description and figure in the following respects:

1. Only the first of the postero-anal photophores lies over the base of the anal fin.

2. The second of the ventral series is less elevated and more obliquely placed with reference to the first ventral. It is distinctly below the line joining the first and second supra-anals.

3. Second and third antero-anals nearly equally elevated, though less so than in *L. jordani*, both well above the level of the first, fourth, and fifth antero-anals. Sixth antero-anal elevated, nearly midway between the fifth and the posterolateral.

4. The luminous scales completely cover the lower margin of caudal peduncle and are eight in number.

No spot on cheek, none above and behind upper pectoral ray, no accessory spots on head or body, and no luminous scales before the adipose; differing in these respects from *L. jordani*.

Humeral spot unusually large, nearly equal in size to the spots on body. Upper infrapectoral on level with upper pectoral rays. First supra-anal much lower than the second, the line joining the two reaching lower profile in advance of third thoracic, passing well above the second ventral. Anals six to nine. Distinctly four precaudals, the first and second dropped below the line of the postero-anals, and separated from them by a slightly wider interspace. The third is more elevated than in *L. jordani*, but is nearer the second than the fourth.

The upper supra-anal, the posterolateral, and the upper precaudal are in contact with the lateral line, but the supraventral is lower, its distance from lateral line one-half its distance from base of ventrals.

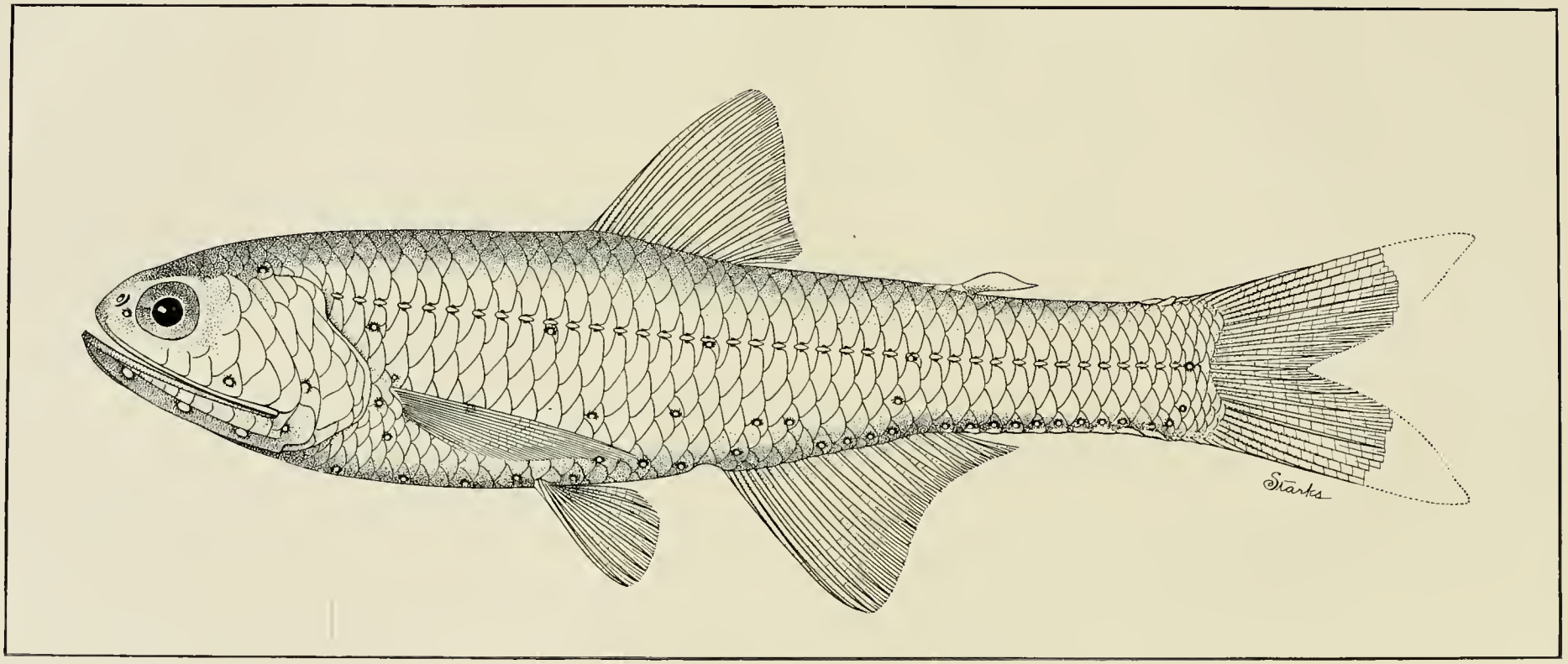
Origin of anal under middle of dorsal or slightly behind that point. Pectorals reaching middle of anal base.

The extent to which these forms vary within the species is still to be determined, so I have not recognized as of specific value the peculiarities of the Japanese specimen here described. One of the specimens figured by Brauer (*l. c.*, fig. 167) varies in so many details from the type, that it may well represent a different species. Unfortunately, Brauer fails to designate any single specimen as his type, and totally neglects to give data for his figures.

FIG. 1. *Dasyscopelus orientalis* GILBERT. Type. Sagami Bay, Japan. C. M. No. 4613.
FIG. 2. *Diaphus glandulifer* GILBERT. Type. Albatross Station 5058, Suruga Bay, 300 fathoms.

FIG. 1. *Diaphus anteorbitalis* GILBERT. Type. Albatross Station 4968, Southern Japan, 253 fathoms.
FIG. 2. *Diaphus gigas* GILBERT. Type. Sagami Bay, Japan. C. M. No. 4601.

FIG. 1. *Diaphus latus* GILBERT. Type. Sagami Bay, Japan. C. M. No. 4604.
FIG. 2. *Diaphus sagamiensis* GILBERT. Type. Sagami Bay, Japan. C. M. No. 4608.



Lampanyctus jordani GILBERT. Type. Nemuro, Hokkaido, Japan. C. M. No. 4617.

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THE GYMNOTID EELS OF TROPICAL AMERICA

BY MAX MAPES ELLIS

PITTSBURGH.

PUBLISHED BY THE AUTHORITY OF THE BOARD OF TRUSTEES OF THE

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September, 1913.

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CARNEGIE MUSEUM.

VOL. VI. NO. III.

THE GYMNOTID EELS OF TROPICAL AMERICA.[1]

By Max Mapes Ellis.

(Plates XV–XXIII.)

Introduction.

In 1909 I undertook the identification of the specimens of Gymnotid eels collected by Dr. Eigenmann in British Guiana. Three new species were found, *Sternarchus leptorhynchus*, *Porotergus gymnotus*, and *Gymnorhamphichthys hypostomus*. The second and third of these represented new genera. Numerous specimens of *Eigenmannia macrops* (Boulenger), a species listed but once before, were also part of this collection. In all five species of Gymnotids were added to the fauna of Guiana.

Subsequently all of the *Gymnotidæ* collected by Mr. John D. Haseman of the Carnegie Museum Expedition to Central South America were received for study. As these collections contained several new species and specimens of many little known species, a revision of the entire family was begun. Mr. Haseman visited many new localities, and his collections were of particular value in the study of the geographical distribution of these fishes.

While engaged in the systematic revision several interesting questions arose. Three in particular may be mentioned: (1) the use of the mental filaments of *Steatogenes elegans* (Steindachner); (2) the relation to their general ecology of the

[1] Contributions from the Zoölogical Laboratory of Indiana University, under the direction of C. H. Eigenmann, No. 116. A thesis accepted as in part fulfilling the requirements for the degree of Doctor of Philosophy, June, 1911.

This paper is a partial report on the Gimbel Expedition to British Guiana and the Carnegie Museum Expedition to Central South America.

frequent injury and subsequent regeneration of the caudal region of the members of this family; and (3) the mode of locomotion.

These questions and others made a study of the living fishes very desirable before the completion of this monograph. This matter was laid before Mr. Jake Gimbel of Vincennes, Indiana, who generously agreed to finance an expedition to British Guiana. In August, 1910, the writer, with Mr. William Tucker, a volunteer assistant, sailed *via* the Quebec Line for Georgetown, British Guiana. Studies of the living *Gymnotidæ* were made in the trenches in and about Georgetown. A trip was made to Hubabu Creek, the first inland fresh-water creek emptying into the Demerara River. The Demerara is still brackish at the mouth of Hubabu Creek. Two excursions were also made to Gluck Island in the Essequibo River opposite Rockstone. This island is about one hundred miles from the coast. Collections were also made in the harbor and on the mud-flats at Georgetown. A new Gymnotid, *Porotergus gimbeli*, was added from Hubabu Creek.

During the spring of 1910, Mr. Bertoni of Puerto Bertoni, Paraguay, sent Indiana University a small collection of fishes from the upper Paraná River. Among these was a specimen of the new species *Gymnorhamphichthys hypostomus*.

The several collections mentioned, as well as the material in the Indiana University Museum, offered an excellent opportunity for a revision of this family. Twenty-two of the twenty-seven known species are in the collections examined, all of the twenty-two being in the collections of the Carnegie Museum. I wish to thank Dr. C. H. Eigenmann for his many helpful suggestions and criticisms. I am deeply indebted to Mr. Jake Gimbel for his generous support of the trip to Guiana, without which certain sections of this monograph could not have been written. I am also under obligations to the Quebec Steamship Line of Quebec and London, and Sproston's Limited of Georgetown, for their grants of transportation, and to Mr. Bernard Conrad of Georgetown, who aided me in many ways during my stay in Guiana.

History of the Literature of the Gymnotidæ.

The first scientific record of any species of this family is that of Georg Marcgraf (1648), who described as "carapo" the species now known as *Gymnotus carapo*. His fish came from Brazil. The name *Gymnotus carapo* was given to this species by Artedi in 1738. He placed it under "Ordo I, Malacopterygii," with the simple description, "*Membrana branchiostega ossiculis quinque. Pinna dorsalis nulla*" (Genera, p. 25, and Synonymia, p. 43). Linnæus under his *Apodes* listed *Gymnotus carapo* and *asiaticus* in the tenth edition, and *Gymnotus carapo, electricus, albifrons, rostratus*, and *asiaticus* in the twelfth edition of the *Systema Naturæ*.

The beginning of real interest in this group of fishes was about forty years before the appearance of the twelfth edition. In 1729 Richter published the first scientific article on the electric eel. This stimulated the study of the *Gymnotidæ*. As a result, scarcely a decade has passed since Richter's paper appeared without the publication of some contribution bearing upon the electric eel or its relatives.

The first step toward segregating the *Gymnotidæ* into a separate family was made by Cuvier (1817) in the *Règne Animal*. He recognized a group, "Les Gymnotes," which he divided into (1) "Les Gymnotes vrais" (the electric eel); (2) "Les Carapes" (*Gymnotus carapo*), and (3) "Les Apternotes" (the Sternarchinæ).

The formal family name was assigned to this group by Bonaparte (1846) in the "Catalogue dei Pesci Europei." Cope, in 1871, restricted the family name *Gymnotidæ* to *E. electricus* and applied the name *Sternopygidæ* to the rest of the group. Gill (1872) replaced the name *Gymnotidæ*, as restricted by Cope, with *Electrophoridæ*, applying the name *Gymnotidæ* to Cope's *Sternopygidæ*. This nomenclature has been used by most subsequent writers.

The family was monographed by Kaup in the "Apodes" of the British Museum in 1856. Steindachner described "Die Gymnotidæ des K. K. Hof-Naturaliencabinetes zu Wien" (Sitzb. d. K. Akad. d. Wissensch., 1. Abth., LVIII, 1868). In 1870 Günther again reviewed the British Museum specimens in Volume VIII of his "Catalogue of the Fishes in the British Museum." In 1905 Eigenmann and Ward published a synoptic revision, "The Gymnotidæ" (Proceedings of the Washington Academy of Sciences, Vol. III, pp. 159–188, 1905). Von Ihering in his "Os Peixes da agua doce do Brazil" (Revista Museu Paulista, Vol. VII, pp. 270–287, 1907), and Schlesinger, in his recent "Die Gymnonoten. Eine phylogynetisch-ethologische Studie" (Zoölogische Jahrbücher, Band 29, Heft 6, 1910), have followed the nomenclature of Eigenmann and Ward almost without change.

Taxonomy.

Order **GLANENCHELI.**

Family GYMNOTIDÆ.

Gymnotidæ Bonaparte, Cat. Metod. dei Pesci Europei, 1846; Kaup, Apodal Fish, 124, 1856; Günther, Cat., VIII, 1, 1870.
Sternopygidæ Cope, Proc. Am. Ass. Adv. Sci., 1871.
Electrophoridæ Gill, Arrangement of the Families of Fishes, 1872.
Gymnotidæ Cope, *l. c.*

Body elongate and eel-like; with or without scales; head naked; dorsal fin wanting, or represented by a dorsal thong; ventrals wanting; anal very long; pectorals small and paddle-shaped; caudal small or wanting; the tail terminating in a cylindrical caudal appendage in the species without a caudal; margin of upper jaw formed by the premaxillary and maxillary; mouth with, or without, teeth; anus never back of the middle of the pectorals, usually well under the head; vertebræ many; shoulder-girdle suspended from the skull; skull with, or without, frontal fontanel, parietal fontanel always present, though much reduced and hidden in two species; symplectic bone present; air-bladder of two parts, the anterior connected with the posterior by a small tube; stomach with a blind sac and pyloric cæca.

The family *Gymnotidæ*, as discussed in this monograph, includes all of the species of the two families, the *Gymnotidæ* and the *Electrophoridæ* as restricted by Gill. The electric eel, *Electrophorus electricus* Linnæus, has been included in this family for two reasons. Its affinities with *Gymnotus carapo* Linnæus are very close, and it is more closely related to the other Gymnotids than to any other group of fishes. The relation of *E. electricus* to *G. carapo* is shown by the following comparison.

I. Characters Common to Both Genera.

Depressed head; body subcylindrical and elongate; teeth large, in one or two rows in each jaw, conical, in sockets; lower jaw slightly projecting; eyes small; no frontal fontanel; parietal fontanel small and almost covered by the overhanging occipitals; posterior air-bladder long and conic; origin of anal fin just below tips of pectorals; anus below gill-opening.

II. Characters Restricted to Electrophorus.

Anal turned up so as to form a false caudal; scales wanting; electric organs well developed.

III. Characters Restricted to Gymnotus.

A small caudal appendage projecting beyond the anal fin; no electric organs, or at least only indications of Hunter's organs; scales present.

It will be seen that the presence of electric organs is the point of largest difference between *Electrophorus* and *Gymnotus* and as pseudo-electric organs are known for other species of the *Gymnotidæ*, it does not seem that *Electrophorus* should stand in a separate family. Plate XVI shows two views of the skull of *G. carapo*. That of *Electrophorus* is the same in almost every detail, except that it is more depressed.

Three subfamilies are recognized. The *Gymnotinæ* just discussed, the *Sternopygin*æ, and the *Sternarchinæ*. The last two named differ from the first especially in two particulars: they are compressed and have both frontal and parietal fontanels. The *Sternopygin*æ differ from the *Sternarchinæ* in the absence of a caudal fin. These two subfamilies parallel each other quite closely in their variations. Plate XV shows an outline of the head of a typical species of each genus of the family. The parallelism of the *Sternopygin*æ and *Sternarchinæ* is particularly evident in the development of long-snouted forms, short-snouted forms, and *toothless* forms. Plates XVII and XVIII show the modification of the skull in the long-snouted *Rhamphichthys rostratus* as compared with the short-snouted *Eigenmannia virescens*, both fishes being of the subfamily *Sternopygin*æ. These plates may be compared with Plate XV as regards the presence or absence of the frontal fontanel.

Boulenger (Archiv für Naturgeschichte, Jahrgang 1904, Bd. I, Heft 2) considers the *Gymnotidæ* as an offshoot from the *Characidæ*. The *Gymnotidæ* seem to

be elongate Characins without dorsal and ventral fins. However, no intermediate forms are known.

Gymnotus carapo Linn. is perhaps the most primitive of the Gymnotids as regards the air-bladder, the skull, and teeth. *Sternarchus albifrons* is, however, more primitive than *G. carapo* in general shape and in the possession of a caudal fin and a dorsal thong. The ancestor of the *Gymnotids* may have been a form combining the primitive characters of both these species.

KEY TO THE SUBFAMILIES AND GENERA OF THE GYMNOTIDÆ.

a. No frontal fontanel; no dorsal filament; no true caudal fin; lower jaw projecting; head depressed; teeth conical, in sockets; posterior air-bladder long, conical; maxillary much reduced. (**Gymnotinæ**).

b. Anal basis extending around the end of the tail, forming a false caudal; electric organs well developed; body not scaled. **1. Electrophorus.**

bb. Anal basis not extending around the end of the slender cylindrical tail; electric organs wanting; body scaled. **2. Gymnotus.**

aa. Large frontal and parietal fontanels; lower jaw not projecting, or at most very slightly; teeth, if present, villiform and without deep sockets, generally placed in patches, maxillary moderate to large.

c. No caudal fin; tail beyond the anal fin slender, pointed, and usually cylindrical; no dorsal filament.

d. Snout short, not tubular. (**Sternopyginæ**).

e. Orbital margin free; teeth in both jaws; posterior air-bladder long, conic as in *Gymnotinæ*. **3. Sternopygus.**

ee. Orbital margin not free.

f. Teeth in both jaws; body much compressed; posterior air-bladder small, subspherical. **4. Eigenmannia.**

ff. Teeth wanting; body subcylindrical; air-bladders separate, the posterior cylindrical.

g. A cylindrical filament in a groove on each side of the mental region; head chubby. **5. Steatogenys.**

gg. No filaments as above; head rather pointed ..... **6. Hypopomus.**

dd. Snout produced and tubular; eyes without free orbital margin; very much compressed and elongate; posterior air-bladder small, subspherical.

h. Body entirely scaled ..... **7. Rhamphichthys.**

hh. Anterior portion of sides naked..... **8. Gymnorhamphichthys.**

cc. Caudal fin and dorsal filament present; tail rather short; eyes without free orbital margin; air-bladder small, subspherical..... (**Sternarchinæ**).

i. Snout much produced; teeth in both jaws.

j. Snout decurved.....**9. Sternarchorhynchus.**

jj. Snout straight.

k. Mouth large or moderate; gape reaching at least one-third of the distance to the vertical from the eye; snout moderate.....**10. Sternarchorhamphus.**

kk. Mouth very small; gape not reaching more than one-sixth of the distance to the vertical from the eye; snout long.....**11. Orthosternarchus.**

ii. Snout heavy and blunt, not produced.

l. Teeth present in both jaws.

m. Back scaled in front of the origin of the dorsal filament.

n. Gape long; angle of the mouth little if any in front of the eye; snout prominent. **12. Sternarchus.**

nn. Gape short; angle of the mouth not reaching beyond posterior nostrils. **13. Sternarchella.**

mm. Back naked to beyond the origin of the dorsal filament; scales along the lateral line large.....**14. Porotergus.**

ll. Teeth of the lower jaw in a single series; upper jaw without teeth....**15. Sternarchogiton.**

lll. Teeth wanting; lower jaw with a distinct V-shaped median groove for the reception of the pointed decurved upper jaw; head rather chubby.....16. **Adontosternarchus.**

I. Electrophorus Gill.

Gymnotus Linnæus, Syst. Nat., ed. XII, i, 1766, 427.
Electrophorus Gill, Proc. Acad. Nat. Sci. Phila., 1864, 151.

Type, *Gymnotus electricus* Linnæus.

No frontal fontanel; anal basis extending around the edge of the tail and forming a false caudal; electric organs well developed on each side of the lower part of the caudal three-fourths of the body; teeth conical, in one row in each jaw; body very elongate; no scales.

The single species of this genus is the remarkable "electric eel" of South America, variously known as the "Porraki" by the Indians, the "numb-fish" by the English settlers, the "Tembladore" or "Tembladore rayados" among Spanish peoples, and as the "Anguille tremblante" in French Guiana.

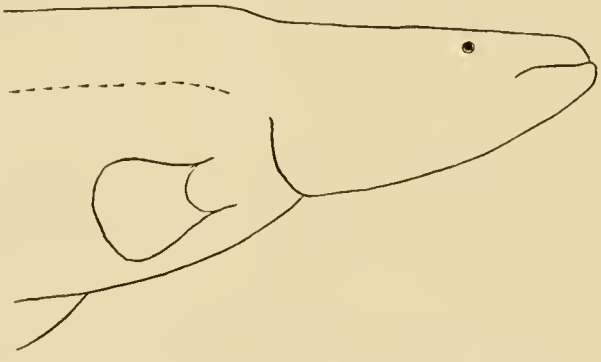


Fig. 1. *Electrophorus electricus* (Linnæus).

1. Electrophorus electricus (Linnæus).

Richter, Mem. Acad. Paris, VII, 1729, 325; de La Condamine, Voy. dans l'Amer. Merid., 1743; idem, Voy. à l'Amazone, 154, 1745 (Para); Ingram, Neue Phys. Belustig., i, 1750, 288; Allemand, Verhand. Maatsch. Haarlem, ii, 1755, 372; Van der Lott, Verhand. Maatsch. Haarlem, D. VI, St. II, 1762 (Essequibo); Bancroft, Essay on Nat. Hist. Brit. Guiana, London, 1769, 191 (Essequibo); Pallas, Spicil. Zool. Petrop., 1769; Bajon, in Rozier, Observ. sur Phys. Hist. Nat., t. III, 47, 1774 (Cayenne); Fermin, Ausführ. Hist. Phys. Kolonie Surinam, Berlin, Bd. ii, 59, 1775 (Surinam); Bajon, Mem. Hist. Cayenne, 1777, ii, 288 (French Guiana); Langguth, Disser. Torpedine, Wittenburg, 1778, 38; Hartsinks, Beschrb. v. Guiana, Berlin, 1784, Vol. 1, 144; Bonaterre, Encyclopedie Methodique, 1787, 22; Van Berkel, Reise nach Rio Berbice, 1789, Th. 1, 220 (British Guiana); Guisan, Obser. Hist. Cayenne, 1789; Rudolphi, Abhandl. Berlin Akad., 1820–21, Physik. Klasse 229; Guerin-Meneville, Iconographie Règne Animal, 1829,

tome I, pl. lxiii, fig. 2; Samo, Electric Eel, Trans. Lond. Elect. Soc., 1841; Hewson, Sydenham Soc., 1846; Hyrtl, Denkschr. K. Akad. Wiss., Nat. Klasse, II, 1851; Appun, Wanderungen Venezuela, Orinoco, British Guiana u. am. Amazon, Bd. I, Jena, 1871, 480.

Gymnotus Seba, Thesaur., III, 108, tab. XXXIV, 1758; Gronovius, Art. Helvet., IV, 1762, 27, tab. 3, fig. i–iii; Musschenbroek, Introd. Philos. Nat. Lugd. Batav., I, 290, 1762; Gronovius, Zoolphyl., 41, No. 169, 1763; Schilling, Neue Abhand. Akad. Berlin, 1770, 68; Musschenbroek, in Rozier, Jour. Phys., 1776, 331; Le Roy, Observ. Mem. Phys., VIII, 331, 1776.

Gymnotus electricus Linnæus, Syst. Nat., ed. XII, Vol. 1, 427, 1766; Williamson, Phil. Trans., LXV, 94, 1775; Garden, l. c., p. 102; Hunter, l. c., p. 395, pls. 1–4; Bloch, Natgesch. Ausländ. Fische, II, 43, taf. 156, 1785; Bryant, Trans. Amer. Philos. Soc., II, 166, 1786; Flagg, Observ. Trans. Amer. Phil. Soc., II, 170, 1786; Guisan, Bull. Sc. Soc. Philom., Vol. I, 32, 1797; Lacépède, Hist. Nat. Poiss., II, 146, pl. 6, fig. 1, 1798; Fahlberg, Kongl. Vetensk. Ak. Ny Handl., Tom. XXII, 122–156, 1801; St. Hilaire, Ann. Mus. Hist. Nat., I, 1–15, 1802; Humboldt, Versuche elect. Fische, 1806; idem, Recuel. Observ. Zool. Anat., Vol. I, 49, 1811; Cuvier, Règne Animal, IV, 236, 1817; Humboldt, Voy. Region Equinox. Nov. Continent, Paris, II, 1819; Guisan, Commt. Gymnoto electrico, Tübingen, 1819; Knox, Edinb. Journ. Sci., I, 96, 1824; Bradley, Charlesworth's Mag. Nat. Hist., II, 668, 1838; Faraday, Philos. Trans., pl. 1, 1839; Schönbein, Beobach. Zitteraales, Basel, 1841; Valentin, Neue Denksch. Allgem. Schweitz. Gesell., VI, pl. 5, 1842; Schomburgk, Fishes Guiana, Part II, 1843, 173 (Rio Negro); Miranda, Exp. sul Gimnoto electrico, Napoli, 1845; Owen, Comp. Anat. Physiol. Vert., part I, London, 1846; Valenciennes, Les Poissons, 110, 1847; Delle Chiaje, Nuov. Ann. Sc. Nat. Bologna, VIII, 5 plates, 1847; Pacini, Sulla electrico Gimnoto, 35, Firenze, 1852; Gronow, ed. Gray, 23, 1854; Kupffer & Keferstein, in Henle & Pfeifer, Zeitsch. f. rat. Med., II, 344, 1858; Jobert, Appareil Poissons Elect., Paris, pl. VII–XI, 1858; Kaup, Apod. Brit. Mus., 124, 1856; *idem*, Wiegm. Arch., XXII, Bd. 1, 1856; Schultze, Abhandl. Naturf. Gesell. Halle, IV, 35, pl. II, 1858; Darwin, Origin of Species, 192, 1859; Steindachner, Gymnotidæ, 14, 1868 (Rio Jacutu; Rio Branco; Rio Guaporé); Günther, Cat. Fish. Brit. Mus., VIII, 10, 1870 (Brazil and Guianas); Wallace, Geograph. Distribution, Lond., Vol. II, 455, 1876; Peters, Mb. Akad. Wiss. Berlin, 1878 (Apuré); Sach, Aus den Llanos, Berlin, 1878 (Apuré); *idem*, Untersuch. am Zitteraal, Leipzig, 1881 (Apuré); Fritsch, Anhang I, Sachs, Zitteraal, 1881; idem, Anhang II; Goeldi, Peixes do Amazonas e Guayanas, 1894; Hargreaves, Fishes of British Guiana, 1904; Pellegrin, Poissons de Guyane Franc., 1908.

Electrophorus electricus Gill, Proc. Acad. Nat. Sci. Phila., 151, 1864; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 61, 1891; Quelch, Nature,

Vol. 55, 508, 1897 (Waini River, Brit. Guiana); von Ihering, Revista Mus. Paulista, 286, 1907 (Amazonia, Guyana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449.

Gymnotus regius Delle Chiaje, N. Ann. Sc. Nat. Bologna, VIII, 1847.

1302 C. M., three, 650 to 825 mm. Tumatumari, Brit. Guiana, Eigenmann.

1754 C. M., 12635 I. U. M., three, 190–580 mm. Creek below Potaro Landing, Brit. Guiana, Shideler.

1755 C. M., one, 460 mm. Pacopoo Pan, Brit. Guiana, Grant.

5100 I. U. M., one, 330 mm. Brazil.

One specimen, Hubabu Creek, Brit. Guiana, Oct. 1, 1910, Ellis.

Head 8 to 9.2; depth 14.5 to 16 in the length to the end of the anal; anal rays 357, 362, 324, in three specimens. Snout about 3.5, interorbital a little less, in the head; eye 5 to 5.2 in the snout, and 15 or 16 in the head.

Body cylindrical, elongate, naked; head depressed; width of the head about equal to, and depth a little less than, the greatest depth of the body; anus a little more than the length of the snout behind the vertical from the eye in front of the pectorals; ventral and dorsal profile almost straight.

Snout heavy and broad; mouth large; gape moderately long, but not quite reaching to below the eye; lower jaw protruding; teeth small, conical, a single row in each jaw; eyes small, without free orbital margin.

Origin of the anal about the length of the head behind the pectorals; anal fin of uniform width and continuing around the end of the tail so as to form a false caudal; pectorals small, fan-shaped, 2.8 to 3.5 in the head.

Ground-color in life olive-green or dark blue to almost black; ventral parts of head and pectoral region light yellow to orange-red; fins dark, fringed with hyaline.

This species is occasionally used for food by the Indians. It is rather generally avoided by the natives on account of the powerful electric shock it can give, that of an eel five feet long being sufficient to knock a man down.

The maximum size for this species, recorded from British Guiana, is seven feet four inches. This specimen was taken by Mr. J. J. Quelch from the Waini River, British Guiana, in 1897, and the skin is now in the Georgetown Museum.

Habitat: Pools and deeply shaded places in small streams and creeks.

Distribution: Orinoco, Guianas, and the Lower and Middle Amazon Systems.

II. Gymnotus Linnæus.

Gymnotus Linnæus, Syst. Nat., ed. X, 246, 1758; ed. XII, 1, 427, 1766.

Type, *Gymnotus carapo* Linnæus.

Size moderate, not exceeding 600 mm. in length. No frontal fontanel; no caudal fin; a caudal filament, no electrical organ; cylindrical anteriorly, somewhat compressed posteriorly; head large and depressed, the top quite flat; gape not reaching the eyes; lower jaw protruding; teeth small, conical, in one row (which

is sometimes a little irregular) in each jaw; eyes small and covered by a membrane, without free orbital margin; scales cycloid and very small; lateral line complete and paralleling the main axis of the body; pectorals small; anal long, its origin back of the vertical from the tip of the pectoral.

A genus of a single species.

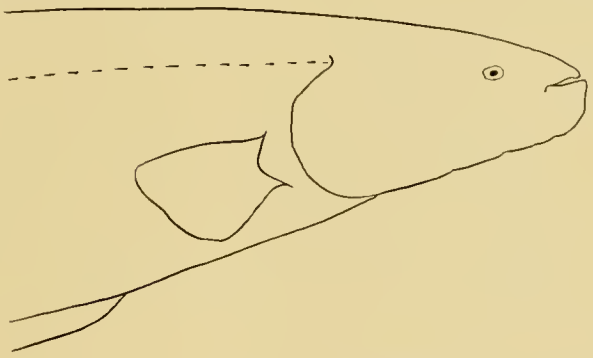


FIG. 2. *Gymnotus carapo* Linnæus.

2. Gymnotus carapo Linnæus.

Carapo MARCG., Hist. Pisc., 170; WILLOUGHBY, Hist. Pisc., 115, tab. G 7, fig. 4.

Gymnotus SEBA, Thesaur., III, tab. 32, fig. 1.

Gymnotus carapo LINNÆUS, Syst. Nat., ed. X, 246, 1758; *idem*, ed. XII, i, 427, 1766; BLOCH, V, 59, tab. 157, fig. 2; GRONOW, Syst., ed. Gray, 22, 1854; GILL, Proc. Acad. Nat. Sci., Phila., 151, 1864; MILLER, Bull. Am. Mus. Nat. Hist., Vol. XXIII, 1907 (Los Amates and Puerto Barrios, Guatemala); EIGENMANN AND BEAN, Proc. U. S. Nat. Mus., Vol. 31, 666, 1907 (Amazon); MEEK, Bull. Field Mus. (Zool. Series Pub. No. 124), Vol. VII, No. 5, 1907 (Los Amates and Lake Amatitlan, Guatemala); *idem*, Bull. Field Mus. (Zool. Ser. Pub., 127), Vol. VII, No. 6, 1908 (Lake Amatitlan, Guatemala).

Gymnotus fasciatus PALLAS, Spicil. Zool., VII, 35; SCHOMBURGK, Fishes of Guiana, 184, pl. 19, 1843 (Rio Branco).

Carapus fasciatus CUVIER, Règne Animal, ed. I, 237, 1817; MÜLLER AND TROSCHEL, Horæ Ichthyol., III, 13, 1849; CASTELNAU, Anim. Amer. Sud., 85, 1855 (Amazon); KAUP, Apod., 139, 1856; STEINDACHNER, Die Gymnotidæ, 13, 1868 (Caiçara, Cuyaba, Marabitanos, Surinam, Matto Grosso); GÜNTHER, Cat., VIII, 9, 1870 (Capim, Bahia, Surinam, British Guiana, Essequibo, Berbice, Trinidad, Is. Grenada, Rio Motagua); HENSEL, Wiegm. Archiv, 89, 1870 (Guahyba, Porto Alegre); COPE, Proc. Am. Philos. Soc., 1870, 570 (Pebas); COPE, Proc. Acad. Nat. Sci. Phila., 1871 (1872), 257 (Ambyiacu); LÜTKEN, Velhas Flodens Fiske, 247, and XIX, 1874 (Rio das Velhas; Lagoa Santa and Rio San Francisco); COPE, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); BOULENGER, Proc. Zool. Soc., 1887, 282 (Canelos); EIGENMANN AND EIGENMANN, Proc. U. S. Nat. Mus., XIV, 1891, 62; PERUGIA,

Ann. Mus. Civico Storia Nat. Genova, 2d ser., Vol. X, 56, 1891 (Central Chaco); Eigenmann, Ann. N. Y. Ac. Sci., VII, 1894, 626 (Braret); Eigenmann, *l. c.*, 635 (Rio Grande do Sul); Cope, Proc. Am. Philos. Soc., 1894, 93 (Rio Grande do Sul); Boulenger, Boll. Torino, X, 3, 1895 (Colonia Risso and Villa Rica, Paraguay); Boulenger, Ann. Mus. Civico, Genova, 1898, 127 (Puerto, 14 de Mayo).

Giton fasciatus Kaup in Dumeril, Analyt. Ichthyol., 201, 1856; Jordan and Evermann, Fishes North and Mid. Amer., 340, 1896 (Guatemala to Rio de la Plata); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1894, 530 (Estancia La Armonia; Campo Grande; Arroyo Trementina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 177 (Rio Motagua to Rio Plata); von Ihering, Os Peixes do Brazil, Part 1 A, 278, 1907 (Ilha-de-S. Sebastião; Rio Doce).

Giton fasciatus var *pantherinus* Steindachner, Akad. Anz., Nr. VIII, März, 1908 (Santos).

Gymnotus albus Pallas, Spicil. Zool., VII, 36, Surinam; Bloch and Schneider, 523, 1801.

Carapus albus Kaup, Apod., 140, 1856.

Gymnotus brachyurus Bloch, Taf. 157, fig. 1, 1787.

Gymnotus putaol Lacépède, Hist. Nat. Poiss., ii, 176, 1800.

Gymnotus carapo Bloch and Schneider, 521, 1801.

Carapus brachyurus Cuvier, Règne Animal, I, 237, 1817.

Carapus inæquilabiatus Valenciennes, in d'Orb. Voy. Am. Merid., Poiss., 11, pl. 14, 1847 (La Plata).

1776 C. M., 12622 I. U. M., thirty-four, 80 to 435 mm. Holmia, Eigenmann.

1777 C. M., 12623 I. U. M., thirty-two, 80–340 mm. Nickaparoo Creek, Wm. Grant.

1778 C. M., 12624 I. U. M., eighteen, 65–310 mm. Creek below Tukeit, Eigenmann.

1779 C. M., 12625 I. U. M., fifteen, 80–380 mm. Aruataima, Eigenmann.

1780 C. M., 12626 I. U. M., twelve, 51–90 mm. Tukeit, Eigenmann.

1781 C. M., 12627 I. U. M., six, 59–105 mm. Below Packcoo Falls, Wm. Grant.

1782 C. M., 12628 I. U. M., four, 125–198 mm. Gluck Island, Eigenmann.

1783 C. M., 12629 I. U. M., five, 130–176 mm. Kumaka, Eigenmann.

1784 C. M., 12630 I. U. M., five, 132–205 mm. Mud Flats, Aruka River, Shideler.

1785 C. M., 12631 I. U. M., five, 80–115 mm. Creek on the Barima River, Shideler.

1786 C. M., 12632 I. U. M., seven, 125–162 mm. Above Kumaka, Eigenmann.

1787 C. M., one, 190 mm. Packcoo Falls, Wm. Grant.

1788 C. M., one, 320 mm. Georgetown Trenches, Eigenmann.
1789 C. M., one, 230 mm. Botanic Garden, Shideler.
1790 C. M., one, 240 mm. Chipoo Creek, Wm. Grant.
1791 C. M., one, 260 mm. Maripicru, Wm. Grant.
3089 C. M., four, 130–290 mm. Santarem, Dec. 11, 1909, Haseman.
3090 C. M., two, 140–220 mm. Puerto Suarez, Bolivia, May 6 and 7, 1909, Haseman.
3091 C. M., five, 120–380 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3092 C. M., two, 100–110 mm. S. Luiz de Caceres, May 23, 1909, Haseman (var. *pantherinus*).
3093 C. M., two, 180–240 mm. Cubatoa, Aug. 1, 1908, Haseman.
3094 C. M., one, 130 mm. Aqua Quente, Nov. 27, 1908, Haseman.
3095 C. M., two, 75 and 95 mm. Raiz do Serra, Rio Mogy, July 26, 1908, Haseman.
3096 C. M., one, 90 mm. Iporanga, São Paulo, Dec. 1, 1908, Haseman.
3097 C. M., one, 160 mm. Morretes, Jan. 3, 1909, Haseman.
3098 C. M., one, 180 mm. Penredo, March 22, 1908, Haseman.
3099 C. M., ten, 100–220 mm. Rio das Velhas, May 13, 1908, Haseman.
3100 C. M., fifteen, 50–130 mm. Campos, June 14, 1908, Haseman.
3101 C. M., ten, 60–145 mm. Entre Rios, July 2, 1908, Haseman.
3102 C. M., two, 130–140 mm. Cacequy, Jan. 31, 1909, Haseman.
3103 C. M., two, 110–200 mm. Cachoeira, Jan. 29, 1909, Haseman.
3104 C. M., three, 130–170 mm. Rio Parahyba, Haseman.
3105 C. M., five, 170–210 mm. Rio Coite, Nov. 6, 1907, Haseman.
3106 C. M., four, 110–170 mm. Xiririca, São Paulo, Dec. 5, 1908, Haseman.
3107 C. M., two, 140–143 mm. Rio Ribiera da Iguape, Dec. 15, 1908, Haseman.
3108 C. M., one, 180 mm. Uruguayana, Feb. 7, 1909, Haseman.
3109 C. M., one, 230 mm. Lagoa Feia, Tocas, June 27, 1908, Haseman.
3110 C. M., one, 130 mm. Aqua Quente, Nov. 22, 1908, Haseman.
3111 C. M., two, 130–210 mm. Barra da Pirahy, July 12, 1908, Haseman.
10299 I. U. M., one, 195 mm. Corumbá.
10062 I. U. M., one, 280 mm. Arroya Trementina.
11239 I. U. M., one, 180 mm. Puerto Barrios, Guatemala.
11307 I. U. M., two, 140–150 mm. Trinidad.
10061 I. U. M., one, 205 mm. Campo Grande.
4896 I. U. M., two, 105–145 mm. Rio Grande do Sul, von Ihering.
1937 I. U. M., one, 150 mm. Rio Paraguay.
11238 I. U. M., one, 150 mm. Los Amates, Guatemala.
11240 I. U. M., five, 110–150. Near Los Amates, Guatemala.
Five specimens, 100–250 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
3112 C. M., one, 150 mm. Hubabu Creek, Oct. 1, 1910, Ellis.

Head 7.25 (old individuals) to 11 (young specimens), depth 8.5 to 14 in the length to the end of the anal; anal rays 200 to 260.[2]

Snout 2.5 to 3; interorbital 2.25 to 3 in the head; eye 4 (young) to 7 in the snout, 4.25 to 6 in the interorbital, 10 to 6 in the head.

Body cylindrical; head depressed; width of the head 1.25 to 1.6, depth of the head at the base of the occipital process 1.3 to 1.8 in the greatest depth; anus near the vertical from a point the length of the snout behind the eye; dorsal profile almost straight; ventral profile slightly convex.

Snout very slightly pointed in young specimens, blunt in adults; mouth rather large; gape straight, reaching about two-thirds of the distance to almost below the eye; upper jaw included; caudal peduncle one-half the length of the snout or less; pectorals 2.25 to 3 in the head; origin of the anal behind pectorals on the vertical from a point about 1.5 times the snout behind the head.

Ground-color of alcoholic specimens varies from a light slate-gray in young specimens to a light orange in adults; a series of transverse white stripes crossing the body in young individuals, which widen and become yellow with age so that the adults are yellow, barred with black; dorsal parts washed with a dark chocolate-brown containing numerous black spots; fins translucent, mottled with black or brown.

In life the body is a translucent flesh-color or pale yellow, varying to a distinct pink in the parts rich in blood. The stripes and markings are blue or green, giving the fish a purplish or olive-green cast. This color may be deepened or lightened slightly by the expansion and contraction of the chromatophores.

The general marking of the species varies considerably, specimens from clear water being darker and more striped than those from muddy water. Some specimens from Guatemala and from the Upper Paraguay are almost without markings.

This fish is eaten throughout South and Central America, but is only prized as a food-fish in Guatemala, where it is rather rare. The Guiana Indians, who know it as the "Warradeela" or "Warraderra,"—Tiger-fish, consider it very good and take it often when poisoning fishes in the dry season, though it is rarely used for food by the whites of Guiana. It is also frequently used for food in Paraguay.

Through Brazil it is variously known as "Felis onca," "Ardea cocoi," "Jacana jacana" and "Carapo." It sometimes reaches the length of three feet.

Habitat: Small, shaded creeks, in slow water.

Distribution: Guatemala, south to the Rio de La Plata, and west to the Andes.

[2] Barima	208	217	218	224	256
Kumaka	212	224	228	240	254
Aruataima	200	215	216	230	260
Nickaparoo	211	217	225	240	260
Holmia	207	220	225	235	245

III. Sternopygus Müller and Troschel.

Gymnotus (in part) Linnæus, Syst. Nat., ed. XII, i, 427, 1766.
Sternopygus Müller and Troschel, Horæ Ichthyol., III, 13, 1849.

Type, *Gymnotus macrurus* Bloch and Schneider.

Readily distinguished from all the other Gymnotids by the free orbital margin. A frontal fontanel, a caudal filament, no caudal; snout short; head large, gape moderate, curved downward and back; jaws equal, or nearly so, upper overhanging on the sides; teeth minute, conical, in two patches more or less confluent (becoming a single patch in older individuals) on the upper jaw, and a single large patch on lower jaw; air-bladder long and conical. Size moderate to rather large; body compressed; maximum depth in the region of the pectorals. Scales cycloid, rather small; lateral line complete, following axis of the body. Origin of the anal in the pectoral region; caudal peduncle moderately long.

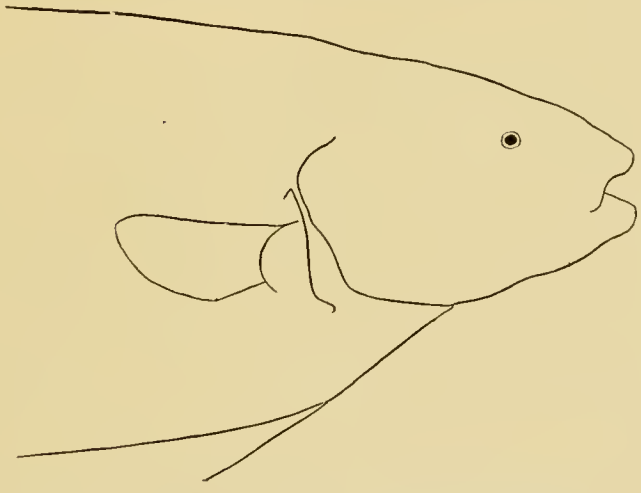


Fig. 3. *Sternopygus macrurus* (Bloch and Schneider).

Species of Sternopygus.

a. Snout pointed, upper profile nearly straight; anal not exceeding three hundred rays. . . . . **macrurus.**
aa. Snout very blunt, upper profile distinctly convex; anal having more than three hundred rays. **obtusirostris.**

3. Sternopygus macrurus (Bloch and Schneider).

Gymnotus macrurus Bloch and Schneider, 522, 1801.
Sternopygus macrurus Müller and Troschel, Horæ Ichthyol., III, 14, 1849; Kaup, Apod., 137, 1856; Steindachner, Die Gymnotidæ, ii, 1868 (Surinam; Rio Branco; Borba; Caiçara); Cope, Proc. Acad. Nat. Sci. Phila., 1871, 257, 1872 (Ambyiacu); *id.*, Proc. Am. Philos. Soc., 1878, 57 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Orinoco, south to Paraguay; Rio das Velhas).
Sternopygus carapus Günther, Cat., VIII, 7, 1870; Lütken, Velhas Flodens

Fiske, 247, and XIX, 1875 (Rio das Velhas); Peters, Mb. Akad. Wiss. Berlin, 1877, 473 (Apuré); Steindachner, Fisch-f. Magdalenen Str., 4, 1878 (Pará); Boulenger, Proc. Zool. Soc., 1887, 282 (Canelos); Steindachner, Flussf. Südam., II, 44, 1881 (Amazon from Pará to Teffé; Xingu at Porto do Moz; Lake Manacapuru; Rio Branco; Borba; Caiçara; Essequibo; Surinam; Maroni River in Guiana); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Perugia, Ann. Mus. Civico Storia Nat. Genova, Ser. 2, Vol. X, 56, 1891 (Central Chaco); Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 626 (Marajo); Boulenger, Trans. Zool. Soc., XIV, 38, 1896 (Paraguay).

Gymnotus carapus Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 175 (Orinoco, south to Paraguay; Rio das Velhas); von Ihering, Os Peixes do Brazil, Part 1 A, 284 (Venezuela, Amazonas, Brazil Central).

Gymnotus æquilabiatus Humboldt, Recueil d'Observat., Zool. et Anat. Comp., i, 46, pl. 10; Kaup, Apod., 142, 1856; Günther, Cat. VIII, 7, 1870; Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 176 (Magdalena and Guayaquil).

Sternopygus æquilabiatus Müller and Troschel, Horæ Ichthyol., III, 15, 1849; Steindachner, Fisch-f. Magdalenen Str., 53, pl. XIV, fig. 1, 1878 (Magdalena River); *id.*, Fisch-f. Cauca and Guayaquil, 36 and 50, 1880 (Cauca and Guayaquil); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Boll. Univ. Torino, XIII, 1898 (Rio Guayas); Steindachner, Denkschr. Acad. Wiss. Wien, LXII, 59, 1902 (Rio Magdalena at Baranquilla); Starks, Proc. U. S. Nat. Mus., XXX, 1906 (Guayaquil); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Magdalena and Guayaquil).

Gymnotus æquilabiatus nigriceps von Ihering, Os Peixes do Brazil, Part 1 A, 285 (Maranhao).

Sternopygus æquilabiatus nigriceps Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450 (Maranhão).

Carapus macrourus Cuvier, Règne Animal, ed. I, II, 237, 1817.

Carapus arenatus Eydoux and Souleyet, Voy. Bonite, Zool., I, p. 210, pl. 8, fig. 2, 1836.

Carapus sanguinolentus Castelnau, Anim. Am. Sud. Poiss., 85, pl. 32, fig. i, 1855 (Urubamba or upper Ucayale).

Sternopygus marcgravii Reinh., Vidensk. Meddel. Naturh. Foren. Kjöbenh., 1852; and Wiegm. Arch., 1854, 180.

1764 C. M., 12541 I. U. M., 104, 155–500 mm. Botanic Garden, Shideler.

1765 C. M., 12592 I. U. M., eighteen, 200–400 mm. Georgetown Trenches, Eigenmann.

1766 C. M., 12593 I. U. M., ten, 150–450 mm. Creek below Potaro Landing, Eigenmann.

1767 C. M., 12594 I. U. M., nine, 65–390 mm. Amatuk, Eigenmann.
1768 C. M., 12595 I. U. M., ten, 118–212 mm. Wismar, Eigenmann.
1769 C. M., 12596 I. U. M., eight, 111–212 mm. Crab Falls, Eigenmann.
1770 C. M., 12597 I. U. M., six, 90–100 mm. Erukin, Eigenmann.
1771 C. M., 12598 I. U. M., three, 115–378 mm. Warraputa, Eigenmann.
3113 C. M., one, 170 mm. Rio das Velhas, May 13, 1908, Haseman.
3114 C. M., three, 190–200 mm. Salto das Cruzes, Rio Tieté, Sept. 22, 1908, Haseman.
3115 C. M., one, 220 mm. Campos, June 15, 1908, Haseman.
3116 C. M., four, 300–350 mm. Penedo, March 22, 1908, Haseman.
3117 C. M., one, 400 mm. Joazeiro, Rio San Francisco, Nov. 28, 1907, Haseman.
3118 C. M., one, 450 mm. Pirapora, Dec. 15, 1907, Haseman.
3119 C. M., seven, 130–380 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3120 C. M., five, 110–175 mm. Rio Jaurú, June 2, 1909, Haseman.
3121 C. M., four, 90–260 mm. Caceres, May 24, 1909, Haseman.
3122 C. M., six, 130–430 mm. Santarem, Dec. 15, 1909, Haseman.
3123 C. M., one, 155 mm. Bastos, June 26, 1909, Haseman.
6316 I. U. M., one, 240 mm. South America.
5091 I. U. M., one, 280 mm. Isl. of Marajo, Brazil.
10300 I. U. M., two, 130–270 mm.
1772 C. M., 12599 I. U. M., six, 128–350 mm. Mud Creek, Aruka River, Shideler.
1773 C. M., 12600 I. U. M., two, 180–195 mm. Konawaruk, Eigenmann.
1774 C. M., one, 430 mm. Issora Rubber Station trenches, Shideler.
1775 C. M., one, 215 mm. Waratuk, Eigenmann.
Ten, 250–370 mm. Georgetown, Sept. 30, 1910, Ellis.
Fourteen, 190–300 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
3124 C. M., three, 200–250 mm. Hubabu Creek, Oct. 1, 1910, Ellis.

Head 6.8 to 7.25, depth 7 to 7.3 in the length to the end of the anal; anal rays 245–299.[3]

Snout 2.75 to 3, interorbital about 3 in the head; eye 3.75 to 4 in the snout, about 4 in the interorbital, and 10 to 13 in the head.

Compressed; width of the head 2 to 2.25, depth of the head in the occipital region 1.8 to 1.5 in the greatest depth; anus about twice the eye behind the vertical from the eye; dorsal profile weakly convex, ventral slightly more convex than

[3] Seventeen specimens taken at random have the anal rays as follows:
Botanic Garden, 256, 270, 270, 277, 278.
Georgetown Trenches, 249, 254, 263, 264, 271, 290.
Potaro Landing, 245, 250, 265, 272, 269.
Issora Rubber Station, 273.

dorsal. Snout heavy, rather pointed, but truncate at the tip; mouth moderate, gape reaching about half-way to the eyes; jaws equal, lower included on the sides.

Caudal peduncle 4.5 to 5 in the total length; pectorals about twice the snout behind the eye.

Ground color of preserved specimens stone-gray to buff; body closely pigmented with minute purple spots, which are more abundant dorsally; a yellowish white lateral streak of variable intensity and width (being almost wanting in some specimens) beginning a little ventrad of the lateral line, at a point about half the total length from the head and continuing well out on the caudal appendage; generally a blue-black spot about twice the size of the eye at the origin of the lateral line; head rather dark above; fins hyaline.

Living specimens are quite translucent, so much so that the backbone and viscera may be seen in outline. The muscles are clear, transparent, appearing bright red on account of the blood contained. With the blue chromatophores and yellow epidermis the general color of the fish changes to orange quite readily. (See Color-changes.) Some specimens from Potaro Landing and others from Aruka and Amatuk were very much darker than the average. Since the ground-color was darker (a dark blue) the lateral stripe appeared more strikingly white in these specimens.

S. macrurus is eaten by the natives and travellers, although it is not a market-fish. It has a very good flavor and rather solid meat. The species of *Sternopygus* and those of *Eigenmannia* are not differentiated by the natives, since the living fishes look very much alike; in fact *Sternopygus macrurus* and *Eigenmannia virescens* can scarcely be separated at a glance in the field. Accordingly these fishes are all grouped under one name: "Cuchillo" or "Cuchilla" in the Spanish-speaking countries, and "Sabre" in French Guiana on account of their "knife-like" shape. Similarly the coolies and natives of British Guiana know these fishes as the "Loga-Loga" or "Laga-Laga." In Ecuador the names "Raton negro" and "Bio" are given to *Sternopygus* alone. The maximum size as given by Humboldt is about three feet.

Habitat: Streams in open or savannah country, trenches, and ditches on plantations.

Distribution: Orinoco, Guiana, Amazons, Rio San Francisco, Rio Magdalena, and west coast of Ecuador.

4. Sternopygus obtusirostris Steindachner.

Sternopygus obtusirostris Steindachner, Flussf. Südam., II, 43, pl. II, fig. 3, 1881 (Amazon at Teffé, Lago Alexo, Manacapuru, Rio Madeira, Rio Puty); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 450.

Gymnotus obtusirostris Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 177 (Amazons and Rio Puty); von Ihering, Os Peixes do Brazil, Part 1 A, 286 (Rio Amazonas, *curso media*).

The following is extracted from Steindachner's original account.

"Snout 3 in the head; eye 7.5 to 10.5 in the head, 2 to almost 4 in the snout, depth of the head about 1.4 (more than 1.3) in the length of the head; head 9.5 to 11 in total length.

"Eye with a free lid, its diameter in young individuals twice the interocular distance, in old specimens about three times the interocular.

"Anal begins slightly in front of the vertical from the base of the pectoral and contains more than three hundred rays.

"The head of this species is noticeably deeper, the snout shorter in profile and more strongly arched than in *Sternopygus carapo* = (*Sternopygus macrurus*)."

It seems quite probable that this species may be but a variety of *Sternopygus macrurus*.

Distribution: Middle Amazons and Rio Madeira; north coast of Brazil.

IV. Eigenmannia Jordan and Evermann.

Sternopygus Müller and Troschel, Horæ Ichthyol., III, 13 (Species).
Cryptops Eigenmann, Ann. N. Y. Acad. Sci., VII, 626 (*humboldtii*). (Preoccupied.)
Eigenmannia Jordan and Evermann, Fishes North and Mid. Amer., I, 341, 1896 (Substituted for Cryptops).

Type, *Sternopygus humboldtii* Steindachner.

Distinguished from *Sternopygus* by the absence of a free orbital margin. With fontanels; no caudal; snout short. Size moderate, not exceeding 400 mm. in length; body elongate and compressed; maximum depth and thickness in the region of the pectorals; head moderate to small, and rather short; gape small, curved downward and back; jaws equal, the lower included on the sides; teeth in two lateral patches in the lower jaw and two almost confluent median patches in upper jaw; mouth rather small; eyes medium, covered by a transparent membrane. Scales cycloid; lateral line complete. Origin of anal back of the vertical from the origin of the pectorals; caudal appendage moderate to quite long.

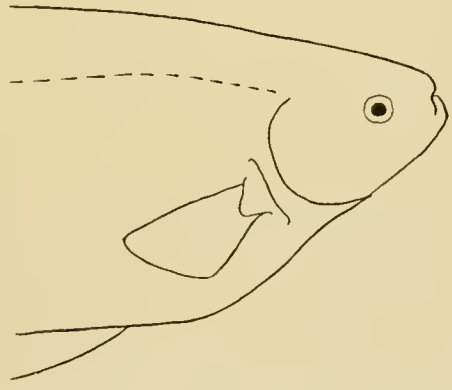


Fig. 4. *Eigenmannia virescens* (Valenciennes).

Species of Eigenmannia.

a. Maxillary shorter than diameter of the eye; eye large; caudal filament long and ribbon-like, equal to about half the total length without the head..... **macrops.**

aa. Maxillary about equal to the diameter of the eye; eye medium; caudal filament cylindrical, less than half the length of the anal..... **virescens.**

aaa. Maxillary about twice the diameter of the eye; eye small; caudal filament less than half the length of the anal..... **troscheli.**

5. Eigenmannia macrops (Boulenger). (Plate XXII, fig. 1.)

Sternopygus macrops Boulenger, Ann. Mag. Nat. Hist. (6), XX, 305 (Potaro River, British Guiana).

Eigenmannia macrops Eigenmann and Ward, 1905, Proc. Wash. Acad. Sci., Vol. VII, p. 172 (Potaro(?) River, British Guiana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Potaro, British Guiana).

1804 C. M., 12601 I. U. M., thirty-two, 165–200 mm. Rockstone, Eigenmann.
1805 C. M., 12602 I. U. M., twelve, 165–180 mm. Tumatumari, Eigenmann.
1806 C. M., 12603 I. U. M., twelve, 125–150 mm. Crab Falls, Eigenmann.

Head 8.25 to 9; depth 6.6 to 7.5 in the length to the end of the anal; anal rays 170–194.[4]

Snout 3.2 to 3.4, interorbital about 3.3 in the head; eye equal to or a little greater than either the snout or the interorbital and 3 or a little less in the head.

Body and head compressed; width of the head 2.25 to 2.5, depth of the head in the occipital region 1.6 to 1.8 in the greatest depth; anus on, or slightly in front of, the vertical from the posterior margin of the eye; dorsal profile almost straight; ventral profile of the head sloping caudad at an angle of 45°; the body tapering; snout short and pointed; mouth very narrow; gape quite short; upper jaw overlapping lower; teeth present in both jaws; eyes large, greater than maxillary.

Caudal peduncle narrow, ribbon-like, equal to about half the total length without the head; pectorals about twice the eye; origin of the anal slightly behind the base of the pectorals, on a vertical from a point about the length of the snout behind the head.

Ground-color pale yellowish brown to almost yellow; origin of the anal rays, the scales of the lateral line and most of the dorsal scales more or less outlined with black; a narrow median dorsal streak of dark brown or black; top of head blue-black; fins hyaline.

Living fishes of this species are quite translucent, the viscera and backbone being visible in outline. General color pink to light red, due to the blood showing through the colorless muscle tissue.

This species, the "Loga Loga," has no food value, being too small. The largest specimen known is 200 mm., taken by Dr. Eigenmann from Rockstone, British Guiana. It is known only from the interior streams of British Guiana.

[4] Rockstone..... 176 178 179 181 194
Tumatumari..... 170 174 182 183 184

6. **Eigenmannia virescens** (Valenciennes).

Sternarchus virescens Valenciennes, in d'Orb., Voy. Am. Merid., Poiss., ii, pl. 13, fig. 2, 1847.

Sternopygus virescens Müller and Troschel, Horæ Ichthyol., III, 14, 1849 (Guiana); Kaup, Apod., 137, 1856; Steindachner, Die Gymnotidæ, 12, 1868 (Matto Grosso, Rio Negro, Guaporé, Marabitanos, Irisanga); Günther, Proc. Zool. Soc., 1868, 229 (Xeberos); Günther, Cat., VIII, 7, 1870 (Surinam, Lagoa Santa, Xeberos); Cope, Proc. Am. Philos. Soc., 1870, 570 (Pebas, Rio Paraná); Cope, Proc. Acad. Nat. Sci. Phila., 1871, 257 (Ambyiacu); Lütken, Velhas-Flodens Fiske, 247 and XIX, 1875 (Lagoa Santa and Rio das Velhas); Peters, Mb. Ak. Wiss. Berlin, 1877, 473 (Apuré); Steindachner, Fisch-f. Magd. Stromes, 55, pl. XIV, fig. 4, 1878; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Cope, *l. c.*, 1894, 93 (Rio Grande do Sul); Boulenger, Trans. Zool. Soc., XIV, 38, 1894 (Descalvados).

Cryptops virescens Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 626; Eigenmann, *l. c.*, 635 (Rio Grande do Sul); Boulenger, Boll. Torino, X, 3, 1895 (Colonia Risso, Paraguay); Boulenger, Ann. Mus. Civico, Genova, 1898, 127 (Puerto 14 de Mayo).

Eigenmannia virescens Eigenmann and Norris, Revista Mus. Paulista, IV, 549 (Piracicaba); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 530 (Arroya Trementina, Paraguay); Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 172 (Rio Magdalena to Rio de la Plata, east of the Andes); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Rio Magdalena to Rio de la Plata, east of Andes).

Sternopygus lineatus Müller and Troschel, l. c., III, 14, 1849, Lake Amucu in Guiana; Kaup, Apod., 138; Steindachner, Die Gymnotidæ, 261, 1868.

Cryptops lineatus Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 635 (Rio Grande do Sul).

Sternopygus tumifrons Müller and Troschel, Horæ Ichthyol., III, 14, 1849 (South America).

Sternopygus microstomus Reinhardt, Vidensk. Meddel. Naturh. For. Kjöbenh., 1852 or Wiegm. Arch., 1854, 181.

Sternopygus limbatus Schreiner and Ribeiro, Arch. Mus. do Rio de Janeiro, XII, 6, 1902 (Amazonas).

Sternopygus humboldtii Steindachner, Fisch-f. Magd. Str., 55, pl. XIV, 1878 (Magdalena); *id.*, Flussf. Südam., I, 21, 1879 (Mamoni R. at Chepo); *id.*, Fischfauna Cauca and Guayaquil, 36, 1880 (Cauca); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Steindachner, Denk. Akad. Wiss. Wien, LXXII, 147, 1902 (Baranquilla on Rio Magdalena).

Cryptops humboldtii Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Marajo).

Eigenmannia humboldti Jordan and Evermann, Fishes North and Mid. Amer.,

341, 1896; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 172 (Marajo, Magdalena, and Mamoni); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Marajo, Magdalena, Mamoni).

1744 C. M., 12605 I. U. M., one hundred and fifty-five, 105–300 mm. Botanic Garden, Georgetown, Shideler.
1745 C. M., 12606 I. U. M., twenty-six, 105–300 mm. Georgetown Trenches, Eigenmann.
1746 C. M., 12607 I. U. M., twenty-four, 110–180 mm. Demerara, Eigenmann.
1747 C. M., one, 80 mm. Rupununi, Grant.
1748 C. M., 12608 I. U. M., four, 120–150 mm. Warraputa, Eigenmann.
1749 C. M., 12609 I. U. M., five, 80–135 mm. Chipoo Creek, Grant.
1750 C. M., one, 190 mm. Wismar, Eigenmann.
1751 C. M., 12610 I. U. M., three, 80–160 mm. Maripicru, Grant.
1752 C. M., 12611 I. U. M., two, 130–190 mm. Creek below Potaro Landing, Shideler.
1753 C. M., one, 100 mm. Kangaruma, Shideler.
1742 C. M., 12604 I. U. M., twenty-nine, 155–290 mm. Wismar, Eigenmann.
1743 C. M., one, 130 mm. Kumaka, Demerara, Eigenmann.
3125 C. M., three, 125–230 mm. Aregua, Lake Ipacary, April 18, 1909, Haseman.
3126 C. M., one, 190 mm. Buenos Ayres, Feb. 20, 1909, Haseman.
3127 C. M., seven, 200–350 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3128 C. M., fourteen, 120–420 mm. Santarem, Dec. 12, 1909, Haseman.
3129 C. M., four, 105–300 mm. San Joaquim, Sept. 4, 5, and 6, 1909, Haseman.
3130 C. M., two, 150–195 mm. Sapina, São Paulo, July 23, 1908, Haseman.
3131 C. M., eight, 115–250 mm. Uruguayana, Feb. 7, 1909, Haseman.
3132 C. M., two, 150–230 mm. Corumbá, April 27, 1909, Haseman.
3133 C. M., one, 210 mm. Rio Mamoré, Sept. 19, 1909, Haseman.
3134 C. M., one, 275 mm. Puerto Suarez, Bolivia, May 6 and 7, 1909, Haseman.
3135 C. M., eight, 50–150 mm. Mogy Guassú, Aug. 25, 1908, Haseman.
3136 C. M., nine, 65–190 mm. Rio das Velhas, May 13, 1908, Haseman.
3137 C. M., thirteen, 100–188 mm. Pirapora, Dec. 15, 1907, Haseman.
3138 C. M., five, 100–130 mm. Sete Lagoas, May 5, 1908, Haseman.
3139 C. M., one, 175 mm. Lagoa Feia, June 16, 1908, Haseman.
3140 C. M., one, 125 mm. Salto das Cruzes, Sept. 22, 1908, Haseman.
3141 C. M., two, 130–145 mm. Cidade de Barra, Dec. 23, 1907, Haseman.
3142 C. M., one, 110 mm. Banhurii, Oct. 17, 1908, Haseman.
3143 C. M., four, 135–140 mm. Itapura, Sept. 27, 1908, Haseman.

3144 C. M., six, 160–205 mm. Campos, June 14, 1908, Haseman.
3145 C. M., one, 120 mm. Villa Bella, Rio Beni, Oct. 5, 1909, Haseman.
3146 C. M., four, 120–210 mm. São João de Barra, June 22, 1908, Haseman.
3147 C. M., six, 120–220 mm. Puerto Suarez, May 6 and 7, 1909, Haseman.
3148 C. M., nine, 50–150 mm. Santa Ritta, Jan. 24, 1908, Haseman.
3149 C. M., five, 110–190 mm. Barrieras, Lagoa of Rio Grande, Jan. 4, 1908, Haseman.
3150 C. M., two, 80–100 mm. Mogy Mirim, Creek of São Paulo, Haseman.
3151 C. M., four, 90–130 mm. Rio Jaurú, June 2, 1909, Haseman.
3152 C. M., three, 95–105 mm. Bastos, June 26, 1909, Haseman.
3153 C. M., one, 85 mm. Bebedouro, Sept. 1, 1908, Haseman.
3154 C. M., two, 90–100 mm. Bogularoa, near mouth of Rio Preto, Haseman.
3155 C. M., five, 100–150 mm. Lagoa de Paranagua, Jan. 16, 1908, Haseman.
3156 C. M., one, 100 mm. São Antonio da Rio Madeira, Aug. 11, 1909, Haseman.
3157 C. M., five, 105 to 140 mm. Caceres, May 24, 1909, Haseman.
3158 C. M., eleven, 65 to 190 mm. No label, Haseman.
3159 C. M., seven, 105–165 mm. Lagoa Pereira, Dec. 23, 1907, Haseman.
3161 C. M., two, 110–160 mm. Januaria, Dec. 12, 1908, Haseman.
3160 C. M., fourteen, 145–215 mm. Joazeiro, Nov. 28, 1907, Haseman.
3162 C. M., seven, 150–190 mm. Penedo, March 22, 1908, Haseman.
5088 I. U. M., one, 275 mm. Island of Marajo.
10303 I. U. M., one, 250 mm. Corumbá.
4895 I. U. M., two, 170 and 180 mm. Rio Grande do Sul.
10056 I. U. M., one, 125 mm. (estimated). Matto Grosso.
9281 I. U. M., one, 180 mm. Piracicaba.
10302 I. U. M., five, 60 to 80 mm. Corumbá.
10783 I. U. M., one, Santos, São Paulo, Brazil.
Thirty-five, 160–320 mm. Georgetown, Sept. 26, 1910, Ellis.
Five, 200–300 mm. Hububu Creek, B. G., Oct. 1, 1910, Ellis.
3163 C. M., two, 210–230 mm. Hububu Creek, Oct. 1, 1910, Ellis.
3348 C. M., one, 250 mm. San Luiz de Caceres, May 23, 1909, Haseman.
3349 C. M., one, 110 mm. Villa Hays, Paraguay, April 13, 1909, Haseman.

Head 7 to 10.5; depth 5.2 to 7 in the length to the end of the anal; anal rays 185 to 224;[5] snout 3 to 3.25, interorbital 2.1 to 3.1 in the head; eye 1 to 2 in the snout, 1.25 to 3 in the interorbital and 3.5 or 6 to the head.

[5] Anal rays in twenty-six specimens.

Botanic Garden	185	188	194	197	
Warraputa	190	191	194		
Georgetown	187	196	197	198	
Wismar	208	210	218	220	224
Kumaka	210				
Joazeiro	200	208	212	216	
Penedo	207	211	212	216	220

Body and head compressed; width of the head 2.25 to 2.4, depth of the head, at base of the occipital process, 1.5 to 2 in the greatest depth; anus on or slightly behind the vertical from the posterior margin of the eye; dorsal profile regularly and moderately convex; ventral profile varying from rather weakly convex to markedly so.

Snout heavy, short and blunt; mouth moderate; gape short to medium; jaws about equal, the lower included on the sides, teeth present in both jaws; eyes small to medium. Caudal peduncle 3.25 to 4.75 in the total length; origin of the anal below, or slightly behind, the origin of pectorals; pectorals about 1.2 in the head.

Ground color of alcoholic specimens, buff; dorsal and dorso-lateral parts more or less overlaid with greenish brown, belly lighter; the lateral line and three stripes which parallel it dark (any or all of these stripes which are ventrad to the lateral line may vary considerably in width and intensity, may even be wanting); a black bar at the origin of each anal ray; fins hyaline; caudal peduncle blue-gray above and pale yellow below.

In life *Eigenmannia virescens* is quite translucent, and is of a bright reddish color. The head and pectoral regions are orange to yellow and the caudal appendage greenish. This species is capable of changing color to some extent (See discussion of color).

The markings of the different individuals vary considerably according to the presence or absence of the dark blue stripes above the anal fin. Specimens from clear water usually show well developed stripes and have the head much darker than those found in muddy water, and may have the anal fin fringed with dusky. The chromatophores are more numerous over the entire body of those from clear water.

This species is classed among the food-fishes, though it is not much sought after by the white people. The coolies of British Guiana seem particularly fond of this fish, which, with the other *Sternopygina*, they call the "Loga-Loga." In addition to the name "Cuchillo" or "Cuchilla" applied to it by most Spanish-speaking creoles, it is known as "Macana" and "Raton blanco" in the United States of Colombia and Venezuela, and "Tuviras" in Brazil. It is found abundantly in the trenches and ditches on the plantations, where it feeds among the weeds. Its natural habitat is in the small streams which flow through savannah or open country in the lowlands.

Because of its large range several varieties have been described as separate species, but these intergrade. "*Humboldti*" of Steindachner may be a distinct variety. It is found along the west coast and in the Rio Magdalena system. Specimens answering its description have been taken in Guiana and Brazil.

Distribution: Rio Magdalena and west coast south over the whole of eastern South America to the Rio de la Plata.

7. Eigenmannia troscheli (Kaup). (Plate XXII, fig. 2.)

Sternopygus troscheli Kaup, Apod., 139, 1856; Steindachner, Die Gymnotidæ, 12, 1868 (Barra do Rio Negro); Günther, Cat., VIII, 8, 1864; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Fisch-f. Magd., 56, 1878 (note); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Eigenmannia troscheli Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 174, 1905 (Amazonas from Manaos to Peru); Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 666, 1907 (Lower Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910 (Amazons, from Manaos to Peru).

Sternopygus axillaris Günther, Cat., VIII, 8, 1864 (Para); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Eigenmannia axillaris Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 174 (Para).

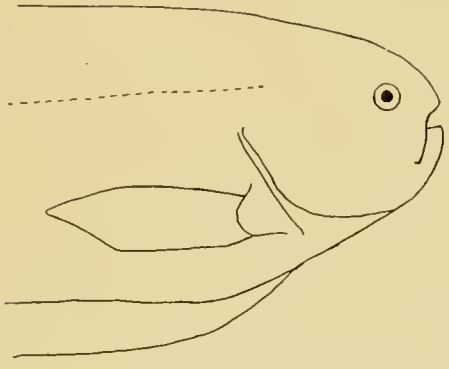


Fig. 5. *Eigenmannia troscheli* (Kaup).

3164 C. M., three, 100–180 mm. San Joaquim, Sept. 5, 1909, Haseman.

Head 7.25 to 8, greatest depth 6.25 to 7.25 in the length to the end of the anal; anal rays 210, 220, 224.

Snout 3.75 to 4, interorbital 3 to 3.75 in the head; eye 2 or a little more in the snout, not quite 2 in the interorbital, 8 or 9 in the head.

Body compressed; head chubby; width of the head 2.25 to 2.5, depth of the head in the occipital region 1.25 to 1.4 in the greatest depth of the body; anus little behind the vertical from the posterior margin of the eye; dorsal profile weakly convex; ventral profile distinctly convex in the pectoral region.

Snout blunt and broad; mouth small; gape quite short, not equalling the diameter of the eye in length; maxillary long, equal to twice the diameter of the eye; jaws about equal, the lower projecting slightly, if at all; teeth in four or five rows around the edge of each jaw, villiform and curved inward slightly.

Caudal peduncle 3.25 to 3.6 in the total length; pectorals 1 to 1.2 in the head; origin of the anal just below the origin of the pectorals.

Ground-color uniform yellowish; top of head and mid-dorsal region, also parts of the caudal portion of the body, more or less sparsely covered with minute black dots; fins hyaline, anal rays very weakly colored with a clear light brown.

Distribution: Lower, Middle, and Upper Amazons.

V. Steatogenes Boulenger.

Steatogenes Boulenger, Trans. Zool. Soc. London, XIV, 1898.

Type, *Rhamphichthys elegans* Steindachner.

With fontanels; no caudal; snout short; distinguished from all the other Gymnotids by the presence of a small cylindrical filament of tissue in a groove on each side of the mental region; otherwise as in *Hypopomus*. Size rather small, not exceeding 250 mm. Fore part of body heavy, caudal portion tapering rapidly into the caudal filament; head chubby; gape short; teeth wanting; mouth rather small; eyes small, covered by a transparent membrane. Scales cycloid, lateral line complete and straight.

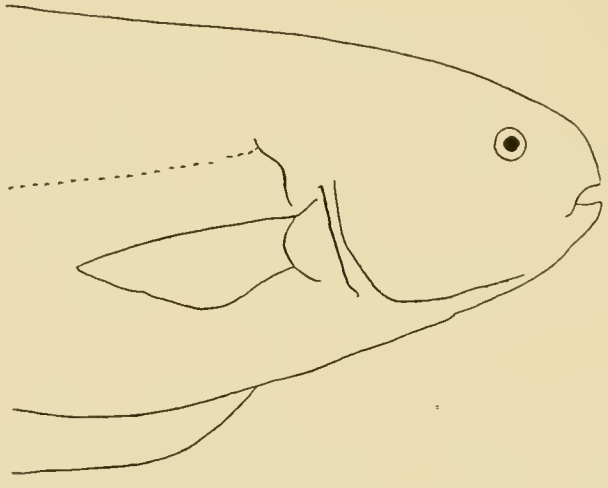


Fig. 6. *Steatogenes elegans* (Steindachner).

8. Steatogenes elegans (Steindachner).

Rhamphichthys (*Brachyrhamphichthys*) *elegans* Steindachner, Fisch-f. Cauca and Guayaquil, 37, 1880 (Barra do Rio Negro).

Brachyrhamphichthys elegans Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Steatogenys elegans Boulenger, Trans. Zool. Soc., XIV, 428, 1898 (Rio Jurua); Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 171 (Barra do Rio Negro); Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Barra do Rio Negro and Guiana).

Rhamphichthys (*Brachyrhamphichthys*) *mirabilis* Steindachner, *l. c.*, pl. IX, figs. i, and ia.

3165 C. M., nine, 120–140 mm. Santarem, Dec. 15, 1909, Haseman.
Six, 110–130 mm. Kumaka, Sept. 12, 1910, Ellis.
1756 C. M., 12614 I. U. M., three, 75–192 mm. Kumaka, Eigenmann.
1757 C. M., one (broken, length estimated 150 mm.). Wismar, Eigenmann.

Head 8.25 to 8.5, depth 5.25 to 5.5 in the length to the end of the anal; anal rays 160, 164, 175 (Kumaka); snout 3.3 to 3.7, interorbital 3, or a little more, in the head; eye 1.5 to 1.75 in the snout, 1.7 to 2 in the interorbital, and about 5 in the head.

Compressed back of the head, which is round and chubby; width of the head about 2.5, its depth in the occipital region 1.6 to 2 in the greatest depth; anus on or a little behind the vertical from the eye; dorsal profile convex; ventral profile abruptly convex to origin of the anal, beyond this very slightly convex.

Snout heavy, blunt; mouth moderate; gape short, not reaching to below the eyes; jaws equal; eyes small; a cylindrical filament about twice the length of the snout, having its origin near the pectoral, lying in a groove on each side of the mental region, both filaments united in median line at the edge of lower lip.

Caudal peduncle not over 2.8 in the total length; pectorals 1 to 1.2 in the head; origin of the anal below that of the pectorals or a little caudad.

Ground-color of preserved specimens dark golden brown, a series of twelve to twenty irregular bands of dark red-brown, starting from the median dorsal line and crossing both the body and the anal fin (these bands are more or less confluent in the region of the lateral line); small golden brown spots on the median dorsal line at the junction of the dark bands from the sides; top and sides of the head almost black, with numerous pale yellow streaks crossing them; cheeks lighter; pectorals mottled with black; anal with numerous brown spots in the yellow interspaces between the brown cross-bands.

This species which, in a general way, resembles the young of *Gymnotus carapo* is sometimes called by the same name, "Warradiera." It is also known by the name "Corybu." It inhabits small streams in densely wooded places and is occasionally used as food cooked with rice by the Indians.

Distribution: Barra do Rio Negro, British Guiana, and Lower Amazon.

VI. Hypopomus Gill.

Hypopomus Gill, Proc. Acad. Nat. Sci. Phila., 1864, 152.
Brachyrhamphichthys Günther, Cat., VIII, 6, 1870, *artedi.*

Type, *Rhamphichthys mülleri* Kaup.

With fontanels; no caudal; snout short; size small; body elongate and rather cylindrical, tapering posteriorly, maximum depth and thickness back of the pectorals; head small, chubby, and conical; mouth and gape small; teeth wanting; eyes

moderate, covered by a transparent membrane. Scales small, cycloid; lateral line straight, complete, rather obscure in caudal region. Origin of anal about the length of the pectoral behind the vertical from the gill-opening; caudal appendage long and slender.

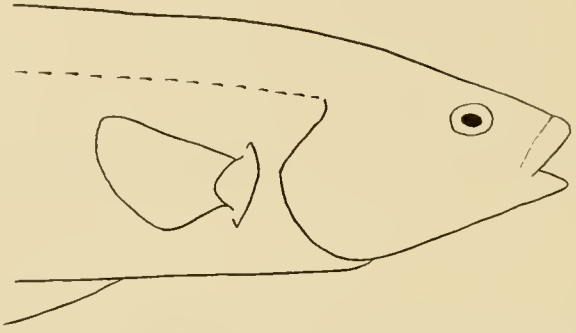


Fig. 7. *Hypopomus brevirostris* (Steindachner).

Species of Hypopomus.

a. Caudal peduncle 4.5 to 5 in the total length; length of the head just equal to, or usually less than, the greatest depth of the body; head somewhat truncate, 8.25 to 9.25 in the length to the end of the anal; eye about 2.5 in the interocular distance ..... **brevirostris.**

aa. Caudal peduncle 3 to 3.5 in the total length; length of the head just equal to, or usually greater than, the greatest depth of the body; head somewhat pointed, 7.5 to 10 in the length to the end of the anal; eye not more than 2 in the interocular distance..... **artedi.**

9. Hypopomus brevirostris (Steindachner).

Rhamphichthys brevirostris Steindachner, Die Gymnotidæ, 6, pl. II, fig. 2, 1868 (Guaporé); Günther, Cat., VIII, 6, 1870; Steindachner, Fisch-f. Cauca and Guayaquil, 37, 1880 (Santarem, Cauca, Rio Guaporé); Perugia, Ann. Mus. Civico Storia Nat. Genova, Ser. 2, Vol. X, 56, 1891 (Central Chaco); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 38 (Descalvados).

Brachyrhamphichthys brevirostris Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Lower Amazon and Itaituba on the Tocantins).

Hypopomus brevirostris Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 530 (Campo Grande, Arroyo Chagalalina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 170, 1905 (Cauca, Amazon and tributaries, Paraguay); von Ihering, Os Peixes do Brazil, 1907 (Amazonas); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (Cauca, Guiana to Paraguay).

10055 I. U. M., two, 140 and 150 mm. Campo Grande.
10057 I. U. M., two, 50 and 65 mm. Arroyo Chagalalina.
10054 I. U. M., one, 140 mm. Matto Grosso.
5097 I. U. M., six, 70–105 mm. Itaituba, Brazil.
5095 I. U. M., two, 90 and 100 mm. Lower Amazon.

3166 C. M., one, 90 mm. Cacequy, Jan. 31, 1909, Haseman.
3167 C. M., two, 75–80 mm. Rio Boa Ventura, June 16, 1909, Haseman.
3168 C. M., two, 65–120 mm. Villa Hays, Paraguay, April 13, 1909, Haseman.
3169 C. M., one, 120 mm. Rio Mamoré, Sept. 19, 1909, Haseman.
4894 I. U. M., eighteen, 75–140 mm. Rio Grande do Sul.
3170 C. M., one, 80 mm. Puerto Suarez, Sept. 19, 1909, Haseman.
1792 C. M., 12615 I. U. M., four, 57–165 mm. Mud Creek, Aruka, Shideler.
1793 C. M., 12616 I. U. M., two, 100–165 mm. Chipoo Creek, Shideler.
1794 C. M., 12617 I. U. M., two, 95–105 mm. Pacopoo Pan, Wm. Grant.
1795 C. M., 12618 I. U. M., four, 118–160 mm. Nickaparoo Creek, Wm. Grant.
1796 C. M., one (broken), 80 mm. Savannah Landing, Eigenmann.
12635 I. U. M., one, 95 mm. Creek below Savannah Landing, Eigenmann.
1797 C. M., one, 117 mm. Twoca Pan, Rupununi, Wm. Grant.
1798 C. M., one, 70 mm. Kumaka, Eigenmann.

Head 8.25 to 9.25, greatest depth 7 to 9 in the length to the end of the anal; anal rays 220 to 260; snout 3.3 to 3.7, interorbital about 3 in the head; eye 2.5 in the interorbital, 2.5 to 3 in the snout, and about 6 in the head.

Body rather cylindrical, though slightly compressed caudad; head chubby, somewhat conic; width of head 2 to 2.5, depth of head in occipital region about 1.75 in greatest depth; anus twice the diameter of the eye behind the vertical from the eye; dorsal profile of the head distinctly slanting, of the body weakly convex; ventral profile regularly convex.

Snout short and truncate; mouth small; gape very short; eyes moderately small; jaws equal.

Caudal peduncle 4.5 to 5 in the total length; pectorals 1.5 to 2 in the head; origin of the anal about the length of the snout behind the origin of the pectorals.

Ground-color buff, overlaid with chocolate-brown; dorsal parts dark; ventral lighter; numerous bands of dark brown crossing the body but not the anal; lateral line buff; head dark; fins bluish white to hyaline; rays more or less black.

Distribution: Rio Magdalena, Guianas, Amazons south to Rio de la Plata.

10. **Hypopomus artedi** (Kaup).

Seba, Thesaur., III, tab. 32, fig. 2.

Rhamphichthys artedi Kaup, Apod., 128, 1856 (Mona); Günther, Cat., VIII, 6, 1870.

Brachyrhamphichthys artedi Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Rhamphichthys mülleri Kaup, Apod., 129, 1856 (French Guiana); Günther, Cat., VIII, 6, 1870.

Hypopomus mülleri Gill, Proc. Acad. Nat. Sci. Phila., 1864, 152.

Brachyrhamphichthys mülleri Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Hypopomus artedi Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 170, 1905 (French Guiana); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (French Guiana).

3171 C. M., one, 150 mm. Iguapé, Rio Ribeira, Dec. 15, 1908, Haseman.
3172 C. M., fourteen, 50 to 160 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.
3173 C. M., thirty-three, 85–265 mm. Campos, June 14, 1908, Haseman.
3174 C. M., one, 180 mm. Uruguayana, Feb. 7, 1909, Haseman.
3175 C. M., four, 130–180 mm. Lagoa Feia, Tocas, June 27, 1908, Haseman.
3176 C. M., three. 70–110 mm. Bragança, Dec. 19, 1909, Haseman.
3177 C. M., two, 55–140 mm. Rio Jaurú, June 2, 1909, Haseman.
3178 C. M., three, 90–130 mm. Santarem, Dec. 15, 1909, Haseman.
3179 C. M., eleven, 55–130 mm. Caceres, May 24, 1909, Haseman.
3180 C. M., eight, 45–120 mm. Bastos, June 26, 1909, Haseman.
3181 C. M., one, 120 mm. Corumbá, April 27, 1909, Haseman.
1799 C. M., 12619 I. U. M., two, 155–165 mm. Lama Stop-Off, Eigenmann.
1800 C. M., 12620 I. U. M., four, 170–174 mm. Wismar, Eigenmann.
1801 C. M., 12621 I. U. M., two, 80–160 mm. Gluck Island, Eigenmann.
1802 C. M., one, 175 mm. Kumaka, Eigenmann.
1803 C. M., one, 130 mm. Christianburg, Eigenmann.

Head 7.5 to 8.25, greatest depth 10 or 11 in the length to the end of the anal; snout 2.9 to 3.5, interorbital 5 to 6 in the head; eye about 2.5 in the snout, 1.8 in the interorbital and 5.8 to 6.8 in the head.

Body compressed and elongate, slightly subcylindrical towards the head; head conic and a little produced; width of the head 1.75 to 2, depth of the head in the occipital region 1.3 to 1.5 in the greatest depth; dorsal profile of the head slightly sloping, of the body almost straight; ventral profile of the head and body somewhat convex.

Snout conic, a little truncate at the tip; mouth medium; gape short; upper jaw barely projecting; eyes small; cheeks round and full.

Caudal filament 3 to 3.5 in the total length; pectorals 1.75 to 2 in the head; origin of the anal about on the vertical from the tip of the pectorals.

Ground-color light buff to straw yellow; dorsal parts and the caudal peduncle crossed by several bands of rather bright brown, which fade out near the middle of each side; ventral parts almost without markings, or with numerous blotches of pale brown; top of the head dark brown; sides of the head and mental region speckled with brown; fins hyaline, rays more or less brown.

Distribution: Guianas, Amazon, Parana.

VII. Rhamphichthys Müller and Troschel.

Gymnotus Linnæus (in part), Syst. Nat., ed. XII, i, 427, 1766.

Rhamphichthys Müller and Troschel, Horæ Ichthyol., III, 15, 1849.

Type, *Gymnotus rostratus* Linnæus.

With fontanels; no caudal; snout long; size moderate to quite large; body very elongate and quite compressed; head moderate, tapering into a long, tubular snout; gape short; mouth small; eyes moderately small and covered by a transparent membrane. Scales cycloid and minute; lateral line complete, straight; origin of the anal in front of the vertical from the gill-opening; caudal appendage large and scaly.

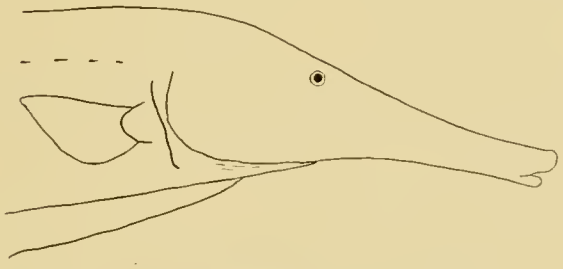


Fig. 8. *Rhamphichthys rostratus* (Linnæus).

11. Rhamphichthys rostratus (Linnæus).

Seba, Thesaur., II, tab. 69, fig. 3, and III, 99, tab. 32, fig. 5.

Gymnotus Gronovius, Mus. Ichthyol., no. 73, 1754; id., Zoophyl., No. 167.

Gymnotus rostratus Linnæus, Syst. Nat., ed. XII, i, 428, 1766; Bloch and Schneider, 522, tab. 106, 1801; Gronow, Syst., ed. Gray, 22, 1854.

Carapus rostratus Cuvier, Règne Animal, II, 237, 1817.

Rhamphichthys rostratus Müller and Troschel, Horæ Ichthyol., III, 15, 1849 (Guiana); Günther, Cat., VIII, 5, 1870 (Surinam); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 168 (Guianas to Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Guianas and Amazon).

Gymnotus longirostris Lacépède, Hist. Nat. Poiss., II, 178, 1800.

Rhamphichthys schomburgkii Kaup, Apod., 135, 10, 1856; Steindachner, Die Gymnotidæ, 10, 1868 (Rio Negro).

Rhamphichthys marmoratus Castelnau, Anim. Amer. Sud. Poiss., 86, pl. 46, fig. 2, 1855 (Uruguay); Kaup, Apod., 132, fig. 7, 1856; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann, Ann. N. Y. Acad. Sci., VII, 1894, 625 (Itaituba); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 168 (Orinoco and Guianas to Rio de la Plata); Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 449, 1910 (Guiana, Orinoco to Rio de la Plata).

Rhamphichthys pantherinus Castelnau, Anim. Amer. Sud. Poiss., 86, pl. 46, fig. 3, 1855 (Lake near the Ucayale); Kaup, Apod., 131, fig. 6, 1856; Günther, Cat., VII, 5, 1870; Peters, Mb. Akad. Wiss. Berl., 1877, 473 (Apuré); Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Fisch-f. Cauca and Guayaquil, 38, 1880 (Manacapuru, Matto Grosso, Surinam, Uruguay, La Plata, Para, Obidos, Xingu, Rio Negro, Ucayale); Perugia, Ann. Mus. Civico Stor. Nat. Genova, ser. 2, vol. X, 55, 1891 (Asuncion and Rio Maciel at Buenos Aires).

Rhamphichthys lineatus Castelnau, Anim. Amer. Sud. Poiss., 87, pl. 47, fig. 1, 1855 (Tributary of Ucayale); Kaup, Apod., 130, fig. 5, 1856.

Gymnotus rostratus (*non* Linnæus) Steindachner, Die Gymnotidæ, 8, 1868, in part (Matto Grosso, Surinam).

Rhamphichthys schneideri Kaup, Apod., 136, fig. 11, 1856 (Cayenne).

Rhamphichthys reinhardtii Kaup, Apod., 132, fig. 8, 1856; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Bean, Proc. U. S. Nat. Mus., XXXI, 666, 1907 (Lower Amazon).

Rhamphichthys blochii Kaup, Apod., 133, fig. 9, 1856; Günther, Cat., VIII, 5, 1860 (Para); Steindachner, Fisch-f. Cauca and Guayaquil, 38, 1880 (Rio Negro, Manacapuru, Para); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 38 (Paraguay); Boulenger, Trans. Zoöl. Soc., XIV, 428, 1898 (Rio Jaurú).

1761 C. M., 12612 I. U. M., three, 580–900 mm. Wismar, Eigenmann.

3344 C. M., one, 300 mm. Berlin, Rio Mamoré, in Bolivia, Sept. 15, 1909, Haseman.

3348 C. M., three, 390–470 mm. San Joaquim, Sept. 5 and 6, 1909, Haseman.

3346 C. M., one, 630 mm. Santarem, Dec. 15, 1909, Haseman.

3347 C. M., one, ? damaged. Santarem, Dec. 15, 1909, Haseman.

Head 6 to 8; greatest depth 11.3 to 12 in the length to the end of the anal; anal rays 410, 444, 469; snout 1.5 to 1.8, interorbital 8.5 to 9.5 in the head; eye 12 to 16 in the snout, 2.25 to 3 in the interorbital, 18 to 22 in the head.

Compressed and very elongate; width of head 2.3 to 2.5, depth of head in the occipital region 1.5 to 2 in the greatest depth; anus on or in front of the vertical from the eye; dorsal profile sloping to the occiput, then almost straight; ventral profile quite straight except for a slight concavity in the mental region.

Snout long, tubular, and tapering; mouth small and slightly below the overhanging upper jaw; gape short and decurved, about 1.5 times the eye; lower jaw included, upper forming the extreme tip of the snout, slightly expanded and blunt on the end, teeth wanting; cheeks full and round; operculum rather prominent; eyes small.

Caudal peduncle 3.5 to 4 in the total length; pectorals 2.75 in the head; origin of the anal about three times the eye behind the vertical from the eye.

Ground-color chocolate to a yellow-brown; ventral parts lighter; numerous

blotches of dark brown and black dorsally; many irregular bands of dark brown spots and blotches crossing the body and anal; anal heavily marked with black and brown spots over a background of cream-white; head dark, mottled with large black and small bluish white spots; mental region almost white, pectorals spotted with black, brown, and white; caudal peduncle dark chocolate-brown, banded with black.

This species is quite variable in size, markings, and length of snout. It is very highly prized as a food-fish. It lives among the roots of the "Mucka Mucka" and a species of Calladium which grow up from the water. It frequents the smaller and more open streams, although it is taken less often in the larger ones. From the contents of the stomachs examined it seems to live almost entirely on mud-inhabiting insect larvæ and worms.

Kaup records this fish as attaining the size of six feet. No such specimens were seen and from the accounts of the fishermen questioned it seems rarely to exceed four and a half feet.

The names of "Band Fish" and "Wabri" were given it by my Guiana coolies.

Distribution: South America, except the Magdalena and Brazilian coastal streams.

VIII. Gymnorhamphichthys genus nov.

Type, *Gymnorhamphichthys hypostomus* Ellis.

Distinguished from all the other Gymnotids except the electric eel by the absence of scales from the anterior part; scales few, confined to the caudal regions; snout straight and produced; other points much as in *Rhamphichthys*. This genus contains but a single species.

12. **Gymnorhamphichthys hypostomus** Ellis. (Plate XXIII, fig. 2.)

Ellis, in Eigenmann, Fishes of British Guiana, Mem. Carn. Mus., Vol. V, p. 436, 1912.

Type, 3182 C. M., 215 mm. San Joaquim, Sept. 5, 1909, Haseman.

Cotypes:

3183 C. M., one, 180 mm. Rio Mamoré, Sept. 19, 1909, Haseman.

12641 I. U. M., two, 140–145 mm. Konawaruk, Eigenmann.

3184 C. M., two, 75 and 115 mm. Bastos, Rio Mamoré, Aug. 3, 1909, Haseman.

3185 C. M., one, 80 mm. Maciel, Rio Guaporé, July 29, 1909, Haseman.

12642 I. U. M., one, 125 mm. Puerto Bertoni, Alto Parana, Bertoni.

12613 I. U. M., three, 95–100 mm. Tumatumari, Eigenmann.

Head 4.8 to 7.1, depth 12.4 to 13.6 in the length to the end of the anal, anal rays 165–210.

Snout 1.6 to 2; interorbital 8 to 14 in the head; eye 7 to 14 in the snout.

Body compressed, slender and quite elongate; width of the head 2 to 2.5;

depth of the head in the occipital region 1.2 to 1.4 in the greatest depth of the body; anus on or a little behind the vertical from the posterior margin of the eye; dorsal and ventral profiles tapering very slightly and almost straight. Snout produced, straight and tubular (the length varies with the size, the largest having the longest snout, hence the range of the measurements in which the head and snout figure). Mouth small, inferior; gape short, from 5 to 8 in snout; jaws almost equal but lower included by the hood-like upper, so that the opened mouth appears under the upper jaw; teeth wanting.

Caudal peduncle 3.5 to 4.5 in the total length; pectorals 1.8 to 2.8 in the head; origin of anal on or very slightly behind, the vertical from the origin of the pectorals.

Ground-color buff; snout and top of head more or less completely covered with black, especially the distal half of the snout; a number of irregular black blotches down the middle of the back, and a second row of black spots more or less confluent with the dorsal ones in the region of the lateral line; caudal appendage completely encircled by two or three black bands (all the black markings vary with the size of the fish, smallest specimens being almost without markings). Fins hyaline.

Distribution: Guiana, Lower Amazon, and Paraná.

IX. Sternarchorhynchus Castelnau.

Sternarchorhynchus Castelnau, Anim. Am. Sud. Poiss., 1856.
Rhamphosternarchus Günther, Cat., VIII, 4, 1870 (*oxyrhynchus*).

Type, *Sternarchorhynchus mülleri* Castelnau.

With fontanels; a caudal fin; snout produced, decurved; size rather small, not exceeding 300 mm. in length; body compressed and slightly elongate, very slender in caudal region; head medium, conical, and produced; gape very small; teeth in both jaws; eyes small and covered by a membrane. Scales cycloid; lateral line complete; origin of anal distinctly in front of the vertical from origin of the pectorals; anal long, widest near the middle of the body and narrowing near both head and tail; caudal fin small, terminal, and fan-shaped, slightly scaled at the base.

13. Sternarchorhynchus oxyrhynchus (Müller and Troschel).

Sternarchus oxyrhynchus Müller and Troschel, Horæ Ichthyol., III, 16, pl. II, figs. 1 and 2, 1849 (Essequibo); Kaup, Apod., 127, 1856; Günther, Cat., VIII, 4, 1870 (British Guiana); Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua).

Sternarchorhynchus oxyrhynchus Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 167 (Guiana and Rio Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910 (Guiana).

Sternarchorhynchus müllcri Castelnau, Anim. Amer. Sud. Poiss., 1855.

Sternarchus mormyrus Steindachner, Die Gymnotidæ, 5, pl. 1, fig. 3 (Marabitanos); Günther, Cat., VIII, 4, 1870 (Peruvian Amazon); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 666 (Lower Amazon); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 167 (Marabitanos, Peruvian Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Peruvian Amazon).

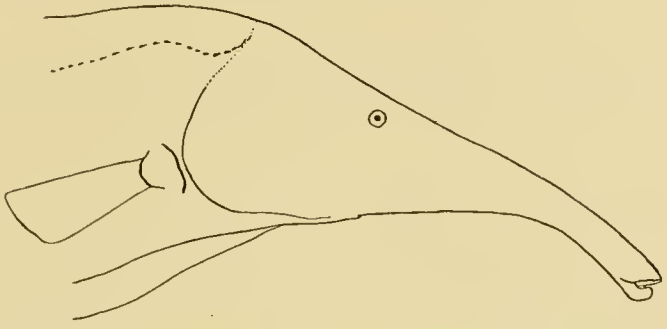


Fig. 9. *Sternarchorhynchus oxyrhynchus* (Müller & Troschel).

Sternarchus (Rhamphosternarchus) curvirostris Boulenger, Proc. Zoöl. Soc., 1887, 282, pl. XXIV (Canelos).

Sternarchorhynchus curvirostris Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1881, 62; Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 167 (Canelos); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Canelos).

3186 C. M., three, 235–260 mm. Santarem, Dec. 12, 1909, Haseman.
3187 C. M., one, 290 mm. Pará, Jan. 22, 1910, Haseman.
1807 C. M., one, 185 mm. Warraputa, Eigenmann.
1808 C. M., 12590 I. U. M., four, 165–240 mm. Amatuk, Eigenmann.

Head 4.8 to 6.9, depth 9.6 to 9.8 in the length to the end of the anal; anal rays 168–215.[6] Snout 1.6 to 1.8, interorbital 13 to 18 in the head; eye equal to the interorbital, 8.5 to 9 in the snout, 13 to 14 in the head.

Body and head compressed; width of head 2.75 to 4, depth of head in the occipital region 1.25 to 1.9 in the greatest depth of the body; anus on, or a little

[6] The number of anal rays of the specimens examined and of the type are

Amatuk, Brit. Guiana	168	168	170	174
Warraputa, Brit. Guiana	180			
Santarem, Brazil	192	196	197	
Para, Brazil	194			

In addition to this list Eigenmann & Bean record specimens of *Sternarchorhynchus mormyrus* from the lower Amazon with 191 to 194 rays (size not given).

in front of, the vertical from the eye; dorsal and ventral profiles behind the head almost straight.

Snout long, tubular, decurved, of small diameter and tapering; mouth small, terminal; gape 1.5 to 2 in the eye; lower jaw included on the sides, slightly projecting in front; teeth small to medium, conical, in two irregular median patches in upper jaw and two irregular series on lower jaw; eyes quite small; mucous pores abundant on the head.

Caudal small, fan-shaped, terminal, 2.5 times the eye; pectorals about 2.75 in the head; origin of the anal about three times the eye behind the vertical from the eye.

Ground-color a uniform bistre to dark brown; head and dorsal parts darker; lateral line hyaline; fins hyaline, rays faintly outlined with dark brown.

The type of *oxyrhynchus* was examined by Dr. C. H. Eigenmann. His notes follow.

"Type in the Berlin Mus. 470 mm. No. 4086, Guiana, Schomburgk.

"Head 6.9 in the length to the end of the anal; anal 215; interorbital 18 in the head. Width of the head near 4 in the greatest depth; depth of the head 1.9 in the greatest depth; anus in front of the vertical from the anterior margin of the eye; gape at least as long as the eye; teeth of both jaws large, recurved, in a single series on the sides, in an irregular double series toward the front."

From a comparison of the anal rays, the size and the shape of the head and snout it seems that *Sternarchorhynchus curvirostris* (Boulenger) and *Sternarchorhynchus mormyrus* (Steindachner) are synonymous with *Sternarchorhynchus oxyrhynchus* (Müller and Troschel), the variations being in part due to the size of the fish.

X. Sternarchorhamphus Eigenmann.

Type, *Sternarchus mülleri* Steindachner.

With fontanels; a caudal fin; snout produced, straight; mouth large; size medium to large; body very elongate and much compressed; maximum depth in, or just behind, the pectoral region; head moderately large to medium, pointed and produced; gape rather straight; small conical teeth in both jaws; eyes small and covered by a membrane; scales cycloid; lateral line complete and quite straight; anal long, growing narrower caudad; caudal very small.

14. Sternarchorhamphus mülleri (Steindachner).

Sternarchus (Rhamphosternarchus) mülleri Steindachner, Flussf. Südam., III, 15, pl. V, fig. 4, 1881 (Para).

Sternarchorhynchus mülleri Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchorhamphus mülleri Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 166 (Pará); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Pará).

3188 C. M., two, 430 and 500 mm. Alcoboca, Rio Tocantins, Jan. 10, 1910, Haseman.

3189 C. M., three, 400–425 mm. Pará, Jan. 22, 1910, Haseman.

Head 8.5 to 9.5, greatest depth of body 9.75 to 10.75 in the length to the base of the caudal; anal rays (Pará) 248, (Alcoboca) 239, 254, 263 (other Pará specimens had regenerated caudals). Snout 1.6 to almost 2; interorbital 6.5 to 8.5 in the head; eye 12 to 15 in the snout and 3 to 5 in the interorbital.

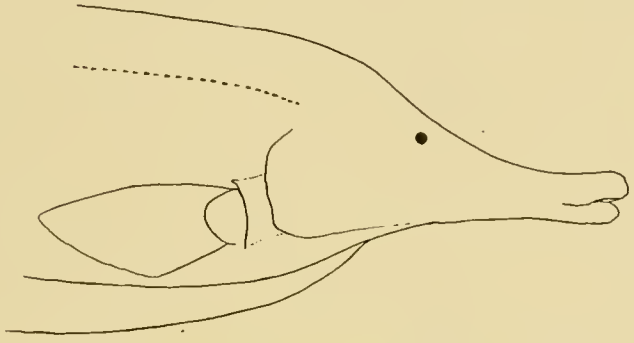


Fig. 10. *Sternarchorhamphus müllcri* (Steindachner).

Body quite compressed and elongate; head compressed and somewhat produced; width of the head 3 to 3.8; depth of the head in the occipital region 1.5 to almost 2 in the greatest depth of the body; anus about the diameter of the eye in front of the vertical from the anterior margin of the eye; dorsal profile almost straight, sloping slightly from the origin of the dorsal filament; ventral profile behind the head weakly convex.

Snout produced, tubular, almost straight, slightly upturned and slightly enlarged toward the tip; mouth medium; gape straight, oblique to the axis of the head and equal to about one fourth of the snout; jaws equal, both rounded in front; lower included on the sides; teeth small, villiform, in a band of three or more series around the lower jaw and a band of two or more series on the side and six or seven series in the middle on the upper jaw.

Caudal fin quite small, 3 to 4 in the snout; pectorals a little more or less than 2 in the head.

Ground-color tawny to dark brown; entire body overlaid more or less with fine violet dots, especially in the region of the lateral line, the dorsal and lateral portions of the head, and the dorsal portion of the body; anal and pectorals bright yellow margined with black; caudal pale yellow; a dark patch at origin of lateral line; scales small, larger in the region of the lateral line; middorsal region unscaled.

Known only from the lower Amazon.

15. Sternarchorhamphus macrostomus (Günther).

Sternarchus macrostomus Günther, Cat., VIII, 4, 1870 (Xeberos).

Rhamphosternarchus macrostomus Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon).

Sternarchorhynchus macrostomus Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchorhamphus macrostomus Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 166 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Peruvian Amazon).

"Snout produced into a long, nearly straight tube, the small eye being midway between the roots of the pectoral and the extremity of the snout. Cleft of the mouth wide; more than half the length of the snout. Mandible with a series of fine teeth on each side. Vent somewhat behind the vertical behind the eye; anal fin commencing in front of the gill-opening; the greatest depth of the body is two-thirds the length of the head; scales on the back and ventral parts very small, those in the middle of the side of moderate size; uniform blackish-brown; posrior part of the anal and caudal black with whitish markings. A. 202." (From Günther.)

This species is found only in the upper Amazon.

XI. Orthosternarchus genus nov.

Type, *Sternarchus tamandua* Boulenger.

Distinguished from the other Sternarchinæ by the long dorsal thong which has its origin above or slightly behind the pectorals, by the long, straight, tubular snout and by the minute eyes and very short gape. Other characteristics much as in *Sternarchorhamphus*.

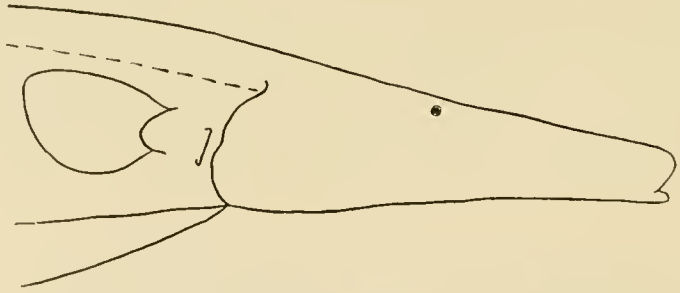


Fig. 11. *Orthosternarchus tamandua* (Boulenger).

16. Orthosternarchus tamandua (Boulenger).

Sternarchus tamandua Boulenger, Trans. Zoöl. Soc., XIV, 427, Plate XLII, 1898 (Rio Jurua, tributary of the Amazon).

Sternarchorhamphus tamandua Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 166, 1905 (Rio Jurua); von Ihering, Os Peixes do Brazil, Part 1 A,

1907 (Rio Jurua); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 449 (Rio Jurua).

"Snout produced into a long, nearly straight tube, the length of which equals 4 times its least depth; mouth very small with several rows of minute teeth; eye extremely minute, a little nearer the opercular cleft than the end of the snout. Depth of body half length of head; a very strongly developed adipose fin runs along the whole length of the body from which it is easily detached; pectoral one-third the length of the head; vent under chin; anal 220, originating a little in advance of gill-opening, its longest rays more than one-half depth of body; scales very small, larger on the upper half of the body than on the lower; lateral line 85. Tail in the unique specimen has been injured during life and bears a short regenerated caudal fin. Uniform yellowish white. Total length 400 mm."
(From Boulenger.)

XII. Sternarchus Bloch and Schneider.

Sternarchus Bloch and Schneider, 497, tab. 94.
Apternotus Lacépède, II, 208.

Type, *Sternarchus albifrons* (Linnæus).

With fontanels; a caudal; snout short; back scaled; gape large; size moderate, not exceeding 500 mm.; body elongate and compressed; maximum depth and thickness in the region of the pectorals; head large, sloping and naked; gape straight, long and parallel to the long axis of the body; lower jaw included by the fleshy sides of the upper; teeth in two rows in lower jaw, two or more rows or patches in upper; eyes small, covered by a membrane. Scales cycloid; lateral line complete and quite straight; back scaled; pectorals never equal to more than one-half the greatest depth; origin of the anal on or a little in front of the vertical from the gill-opening; anal long but not reaching the caudal, of rather uniform height; caudal rather small.

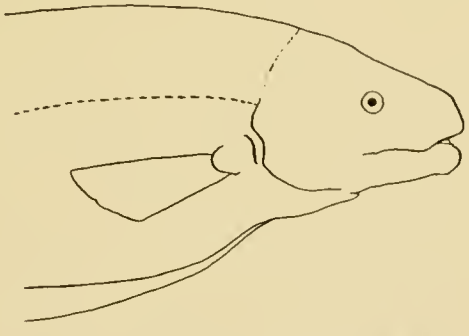


Fig. 12. *Sternarchus albifrons* (Linnæus).

Species of Sternarchus.

a. Scales small, 11 to 16 rows above the lateral line.
b. Snout rather pointed, interorbital distance more than 5 in the head.
c. Greatest depth of the head 1.25 to 1.5 in its length; interorbital 3 or less than 3 in the snout. **brasiliensis.**

cc. Greatest depth of the head 1.8 to 2 in its length; interorbital 4 or more in the snout. **leptorhynchus.**

bb. Snout blunt, interorbital distance less than 4.75 in the head.

d. Rather slim; flesh-color to light gray, entirely covered with numerous fine dark chromatophores. **hasemani.**

dd. Robust; ground-color dead black; two white bands circling the body, one at the base of the caudal, and another near the end of the anal; forehead more or less white..... **albifrons.**

aa. Scales above lateral line large, in not to exceed eight rows..... **bonaparti.**

17. Sternarchus brasiliensis Reinhardt.

Sternarchus brasiliensis Reinhardt, Vidensk. Meddel. Naturh. Foren. Kjöbenh., 1852, or Wiegm. Arch., 1854, 182 (Rio das Velhas); Günther, Cat., VIII, 3, 1870 (Rio das Velhas); Steindachner, Flussf. Südam., III, 14, 1881 (Rio das Velhas); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 61 (Rio das Velhas); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 162, 1905 (southeastern Brazil); von Ihering, Os Peixes do Brazil, Part 1 A, 1907 (Rio Piracicaba; Rio Sapucay; Rio Tieté); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Rio San Francisco, Paraná and Paraguay).

Sternarchus albifrons Eigenmann and Norris, Revista Museu Paulista, IV, 349, 1900 (Piracicaba); not of Linnæus.

3190 C. M., two, 250–290 mm. Pirapora, Dec. 15, 1907, Haseman. (Pirapora is on the Rio San Francisco, just above the mouth of the Rio das Velhas.)

Head 7.25 to 8, depth about 9.25 in the length to the end of the anal; anal rays 184 and 194. Snout 2.3 to 2.4, interorbital a little more than 5.5 in the head; eye 2 to 3.1 in the interorbital, about 6.25 in the snout, and 13 or 14 in the head; 11 to 16 rows of scales above lateral line.

Body and head compressed; width of the head 2 to 2.25, depth of the head at the base of the occipital process about 1.25 in the greatest depth; anus on the vertical from a point twice the eye behind the eye; dorsal profile weakly convex, ventral almost straight; top of head sloping rather abruptly.

Snout moderate, rather cylindrical and truncate on the end; mouth large; gape long, almost reaching the vertical from the eye; lower jaw included in the sides; jaws about equal, both with teeth; eyes small.

Caudal 1.2 to 2 in the snout; origin of the anal on, or in front of, the vertical from the gill-opening; pectorals about 2 in the head.

General color dark brown, lighter ventrally; caudal black with a white spot at its base; anal and pectorals hyaline.

This species seems to have arisen in the Serra da Matto da Corde, in the State of Minas Geraes, Brazil, as it is found only in and about these mountains.

It is known only from the Rio das Velhas, the upper Rio San Francisco and the portions of the Rios Piracicaba, Sapucahy, and Tieté nearest the Serra da Matto da Corde.

18. **Sternarchus leptorhynchus** Ellis. (Plate XXII, fig. 4.)

Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 439.

1762 C. M., type, 260 mm. Amatuk, Eigenmann.
12588 I. U. M., cotype, 160 mm. (Length estimated; specimen broken.) Amatuk, Eigenmann.
1763 C. M., cotype, 98 mm. Warraputa, Eigenmann.

Head 4.9 to 5.2, greatest depth about 6.75 in the length to the end of the anal; anal rays 158–160; snout 2.2 to 2.3, interorbital 6.5 to 7.5 in the head; eye about 9 in the snout, 20 to 22 in the head, and 3 to 4 in the interorbital; 13 to 15 rows of scales above the lateral line.

Compressed and elongate; width of the head 3 or a little more, depth of the head in occipital region 1.3 to 1.5 in the greatest depth of the body; anus about 4 orbital diameters behind the vertical from the eye; dorsal profile of the head and anterior sixth of the body abruptly sloping ventrally, dorsal profile of the remainder almost straight; ventral profile very weakly convex or almost straight.

Snout heavy, rather long and slightly rounded; mouth large; gape reaching to just below the eyes; jaws equal, the lower included; teeth minute, conical, and few, in two irregular, somewhat incomplete rows along each side of the lower jaw and in two irregular patches on the upper jaw.

Caudal 3.8 to 4, pectorals 2 to 2.25 in the head; origin of the anal about the length of the snout behind the vertical from the eye.

Color a uniform, dark seal-brown; a dirty white spot at the origin of the caudal; a more or less interrupted pale yellow streak running along the median dorsal line from the tip of the snout to middle of the back or farther (this streak is a distinct band in the smallest specimens); lips cream-white; fins hyaline; rays outlined with dark brown.

Known only from British Guiana.

19. **Sternarchus hasemani** sp. nov.[7] (Plate XXIII, fig. 1.)

3191 C. M., type, 170 mm. to base of caudal. Santarem, Dec. 15, 1909, Haseman.
3192 C. M., cotypes, nineteen, 150–200 mm. (length not definite as all have the caudal region in various stages of regeneration). Santarem, Dec. 15, 1909, Haseman.

Head 1 to 1.25 in the greatest depth of the body; snout 2.8 to 3.5 in the head; interorbital 1.2 to 1.5 in the snout, about 3 in the head; eye 4 to 5 in the snout, 10 to 12 in the head; 11 to 15 rows of scales above the lateral line.

Body compressed; head somewhat conic; width of the head 2.3 to 3, depth of

[7] Named for Mr. John D. Haseman, who collected all of the specimens of this species.

the head in the occipital region 1.5 to 1.75 in the greatest depth of the body; anus about the diameter of the eye behind the vertical from the posterior margin of the eye; dorsal profile almost straight; ventral profile convex.

Snout heavy and blunt, mouth moderately large; gape somewhat curved downward, long, almost reaching the vertical from the anterior margin of the eye; jaws equal, lower included on the sides; teeth in two irregular rows in each jaw; eyes medium, covered by a membrane; nostrils prominent, the anterior nares projecting slightly as little tubercles; upper posterior margin of the operculum somewhat angulate; first few scales of the lateral line quite prominent.

Pectorals 1.3 to 1.6 in the head; origin of the anal on, or slightly in front of, the vertical from the gill-opening.

Ground-color pale buff; body completely covered with extremely fine brown dots, causing a brownish shade; top of head lighter, with a more or less distinct white band running from middle of snout to beyond the occipital region; sides and under parts of the head heavily covered with minute blue-black dots; fins smoky to almost black, being colored irregularly.

The caudal fin and a portion of the caudal region of all of the specimens examined were in various states of regeneration.

20. **Sternarchus albifrons** (Linnæus).

Gymnotus albifrons Linnæus, Syst. Nat., ed. XII, i, 428, 1766; Pallas, Spic. Zool., VII, 36, tab. 6, fig. i, 1769; Bonaterre, Tabl. Encycl. des Trois Règnes Natura, Poiss., 37, pl. 24, fig. 82, m. 3, 1788.

Sternarchus albifrons Bloch and Schneider, 497, tab. 94; Castelnau, Anim. Amer. Sud. Poiss., 91, pl. 45, fig. 1, 1855; Kaup, Apodes, 126; Steindachner, Sb. Akad. Wiss. Wien, LVIII, 1868, 249 (Cuyabá); Günther, Cat., VIII, 2, 1870 (Pará, Santarem); Peters, Mb. Ak. Wiss. Berlin, 1877, 473 (Apuré); Cope, Proc. Am. Philos. Soc., 1878, 282 (Canelos); Steindachner, Flussf. Südam., III, 13, pl. 5, fig. 6, 1881 (Manacapuru, Teffé, Obidos); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 61; Perugia, Ann. Mus. Civico Stor. Nat. Genova, Ser. 2, Vol. 4, 55, 1891 (Asuncion); Boulenger, Trans. Zoöl. Soc., XIV, 1896, 37 (Descalvados); Boulenger, Boll. Torino, XIII, 1898 (Rio Zamora, Ecuador); Eigenmann and Kennedy, Proc. Acad. Nat. Sci. Phila., 1903, 30 (Arroyo Trementina); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 162 (Orinoco, Amazons, Paraguay); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Guiana, Amazons, Paraguay).

Apteronotus passan Lacépède, Hist. Nat. Poiss., II, 209, pl. 6, fig. 3, 1800.

Sternarchus lacepedii Castelnau, Anim. Amer. Sud. Poiss., 93, pl. 45, fig. 3, 1855 (Surinam).

Sternarchus maximilliana Castelnau, l. c., 93, pl. 45, fig. 4, 1855.

3193 C. M., one, 400 mm. Pará, Jan. 22, 1910, Haseman.

10058 I. U. M., one, 290 mm. Arroyo Trementina.
One, 180 mm. Hubabu Creek, Oct. 1, 1910, Ellis.
1760 C. M., 12589 I. U. M., six, 105–285 mm. Creek below Potaro Landing, Eigenmann.

Head 5.8 to 6.2; depth 5 to 5.5 in the length to the end of the anal; A. 155, 158, 164, 168, 170 respectively; snout 2.7 to 2.9, interorbital 3.25 to 3.5 in the head; eye 3.25 to 3.5 in the snout, 2.8 to 3 in the interorbital, 8.5 to 9 in the head; 11 to 13 rows of scales above lateral line.

Compressed and slightly elongate; width of the head 2.5 to 2.8, depth of head in occipital region 1.25 to 1.5 in the greatest depth; anus on, or a little behind, the vertical from the posterior margin of the eye; dorsal profile rather straight back of the head which slopes ventrally; ventral profile slightly concave, except below the pectorals, where it is somewhat convex.

Snout heavy, truncate and rather short; mouth large; gape reaching to just below the eyes; jaws strong, lower included on the sides; teeth minute and conical, in two irregular rows in lower jaw and two circular patches (one on each side of the median line) in the upper jaw.

Caudal about 5, pectorals 1.2 to 1.4 in the head; origin of the anal in front of the pectorals, about 4 times the eye behind the vertical from the eye.

Ground-color of preserved specimens dead black; a dirty white band about 1.5 times the eye in width extending, in the median dorsal line, from the tip of the snout to the top of the head; two cream-white bands completely encircle the fish, the first beginning at about the 130th anal ray and continuing to the end of the anal, the second a smaller one at the origin of the caudal; anal opening, and sometimes the extreme tip of the caudal, white; eye in alcoholic specimens a bright China blue; fins and rays dead black.

In living specimens the white bands vary from rose-pink, or heliotrope, to red, and the eyes are quite red, the black parts being olivaceous.

This fish is regarded by some of the natives of Guiana with superstition. It is thought to be often inhabited by a ghost of some departed person or evil spirit. It is called "Cheeogaa" by these Indians. Natterrer gives the name "Man tschiogaa" as that of the Indians near Cuyabá. The Brazilians call it "Tovira cavallo."

Habitat: Small creeks.

Distribution: Orinoco, Guianas, Amazons, Ucayale, Rio Paraguay, and Rio Paraná.

21. **Sternarchus bonapartii** Castelnau.

Sternarchus bonapartii Castelnau, Anim. Amer. Sud. Poiss., 92, pl. 45, fig. 2, 1855 (Amazon); Kaup, Apod., 126, 1856; Günther, Cat., VIII, 3, 1870; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Flussf. Südam., II, 42, 1881 (Manacapuru); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Eigenmann and Ward, Proc. Wash.

Acad. Sci., VII, 1905, 163 (Amazons); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazons).

Sternarchus macrolepis Steindachner, Flussf. Südam., III, 14, pl. V, fig. 7, 1881, near Barra do Rio Negro and Lake Manacapuru; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua); Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 163 (Amazon near Rio Negro and Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazon, Rio Negro, Guiana).

3194 C. M., one, 95 mm. Rio Mamoré, Sept. 19, 1909, Haseman.

3195 C. M., one, 160 mm. (estimated, caudal portion gone and partly regenerated). Santarem, Dec. 15, 1909, Haseman.

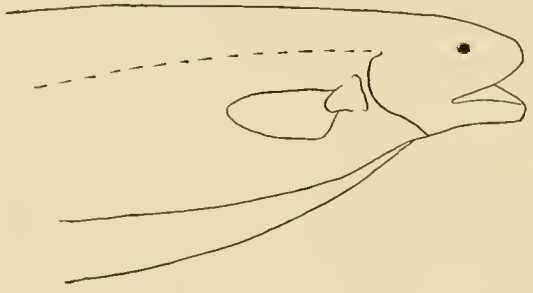


Fig. 13. *Sternarchus bonapartii* Castelnau.

Head 5.75 to 6, greatest depth of the body 8.75 to 9 in the length to the base of the caudal; anal rays 163; a maximum of 8 rows of scales above the lateral line.

Snout 2.5 to 2.75, interorbital 4.25 to 4.7 in the head, eye 4 to 4.5 in the snout; about 2 in the interorbital, and 11 or 12 in the head.

Body and head compressed, depth of head in the occipital region about 1.3, width of the head a little more or less than 2 in the greatest depth of the body; anus a very little behind the vertical from the posterior margin of the eye; dorsal profile of the head weakly convex; dorsal part of the body sloping very slightly, ventral profile almost straight.

A comparison of *Sternarchus bonapartii* and *Sternarchus macrolepis* Steindachner with the above specimens shows *macrolepis* to be synonomous with *bonapartii*.

Distribution: Lower and Middle Amazons and Rio Ucayale.

XIII. Sternarchella Eigenmann and Ward.

Sternarchella Eigenmann and Ward, Proc. Wash. Acad. Sci., Vol. VII, 1905, 163.

Type, *Sternarchus schotti* Steindachner.

Like *Sternarchus*, the gape short; size rather small to medium; body rather compressed; gape not reaching beyond the posterior nostril; eyes small, covered

by a membrane, nearer the tip of the snout than to the gill-opening; small teeth in both jaws. Scales cycloid, moderately large.

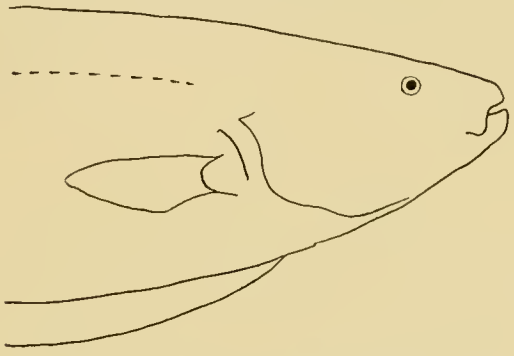


Fig. 14. *Sternarchella schotti* (Steindachner).

Species of Sternarchella.

a. Depth of head 1.5 to 1.25 in its length; gape moderate, reaching to below posterior nostril . . . . . **schotti.**
aa. Depth of head equal to its length; gape short, just reaching to below the anterior nostril. . . . . **balænops.**

22. Sternarchella schotti (Steindachner).

Sternarchus schotti Steindachner, Die Gymnotidæ, 4, pl. 1, figs. 1 and 2, 1868 (Barra do Rio Negro); Günther, Cat., VIII, 3, 1870; Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Steindachner, Flussf. Südam., II, 42, pl. 2, fig. 2, 1881 (Manacapuru); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchella schotti Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 164 (Amazons); Eigenmann and Bean, Proc. U. S. Nat. Mus., Vol. 31, 665, 1907 (Lower Amazon); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Amazons).

3196 C. M., five (all with the caudal region more or less mutilated), length estimated 130 mm. more or less. Santarem, Dec. 15, 1909, Haseman.

Snout 3.1 to 3.4, interorbital 5.25 to 6 in the head; eye 3 to 4 in the snout, about 2 in the interorbital, and 10 to 12 in the head; depth of the head in the occipital region 1.5 to 1.75 in the length of the head.

Body and head compressed, both rather elongate; anus between the vertical from the eye and that from the posterior nares; dorsal profile almost straight; ventral weakly convex in the pectoral region.

Snout straight or very slightly sloping and rather blunt; mouth moderately large; gape curved and short, not reaching beyond the vertical from the posterior nares; jaws about equal, the lower appearing longer when the mouth is open, and included by the upper on the sides when closed; teeth quite small, in two semicircular rows in each jaw.

Origin of the anal on or slightly in front of the vertical from the origin of the pectorals; pectorals 1.3 to 1.5 in the head.

Ground color pale straw-yellow; mid-dorsal region and top of head quite dark, being almost completely covered with minute black dots, lateral portions of the dorsal region less heavily dotted; sides very sparsely sprinkled with fine dark brown dots; origins of the anal rays faintly outlined with minute spots; cheeks with a very few rather prominent dark brown dots; fin-membranes hyaline, rays more or less brownish.

This species is found only in the Amazon system.

23. Sternarchella balænops (Cope).

Sternarchus balænops Cope, Proc. Am. Philos. Soc., 1878, 682 (Peruvian Amazon); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchella balænops Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 164 (Peruvian Amazon); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Peruvian Amazon).

"Profile oblique, with a depression between the orbits; snout short and much narrowed; lower jaw large, projecting beyond the upper both anteriorly and laterally, enclosing the latter somewhat as in a whalebone whale. The fissure of the mouth is short, only reaching the vertical line from the anterior nostril. Eyes small, without free border, much nearer the snout than the gill-opening, one-twelfth the length of the head, which latter enters the length without the caudal fin, 8.5 times. The depth at the base of the dorsal thong is equal to the length of the head. Anal radii 171. Scales very large, in only nine longitudinal rows at the base of the dorsal thong. Color olivaceous, with a pale dorsal band which reaches the dorsal thong, and a pale narrow band on each side near the dorsal band. Length 165 mm.; length to origin of anal 20 mm.; length to base of dorsal thong 96 mm.

"This species resembles remotely the *S. Schotti* of Steindachner, but differs from it and from all the other species in the much enlarged mandible and large scales." (After Cope.)

XIV. Porotergus Ellis.

Porotergus Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., V, 1912, 440.

Type, *Porotergus gymnotus* Ellis.

Distinguished from the other *Sternarchinæ* by the absence of scales along the middle of the back to beyond the middle of the dorsal thong; gape rather long, almost reaching vertical from the eye; scales in region of lateral line quite large; body rather elongate.

Species of Porotergus.

a. Head 7 to 7.75 in the length to the base of the caudal; snout 2.2 to 2.5 in the head; anal rays 130 to 150. *gymnotus*.

aa. Head 8.5 to 10.25 in the length to the base of the caudal; snout 2.5 to 3 in the head; anal rays 175 to 180. *gimbeli*.

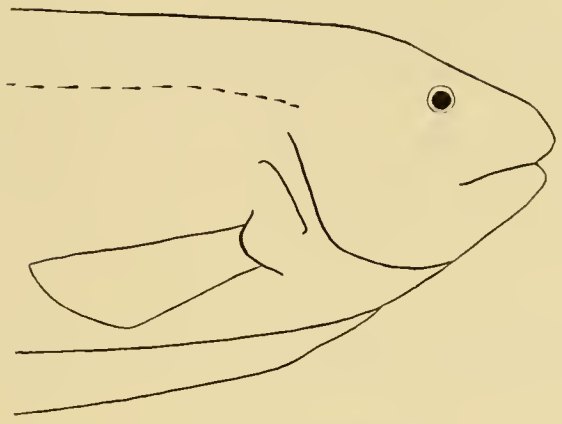


FIG. 15. *Porotergus gimbeli* Ellis.

24. Porotergus gymnotus Ellis. (Plate XXIII, fig. 4.)

Porotergus gymnotus ELLIS, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 441.

1759 C. M., type, 70 mm. Amatuk, Eigenmann.
12636 I. U. M., cotype, two, 68 and 85 mm. Amatuk, Eigenmann.
1758 C. M., cotype, one, 62 mm. Konawaruk, Eigenmann.

Head 6 to 6.5, greatest depth 6.2 to 6.7 in the length to the end of the anal. Anal rays 130–147[8]; snout 2.2 to 2.5 in the head, interorbital about the same; eye 5 or 6 in the snout and 12 to 14 in the head; 5 to 8 rows of scales above the lateral line; mid-dorsal space naked and abundantly supplied with mucous pores.

Compressed and slender; depth of the head in occipital region 1.25 to 1.5 in the greatest depth; anus not quite the length of the snout behind the vertical from the eye; dorsal profile behind the head almost straight, the head sharply sloping; ventral profile slightly convex, save in the mental region, where it is rather concave.

Snout heavy and somewhat truncate; mouth moderately large; gape straight, not quite or barely reaching below the eye; jaws stout, lower included on the sides; teeth few, small, conical, in two irregular interrupted rows, the inner one of the lower jaw represented by but three or four teeth, two small patches of not over six teeth each in the upper jaw.

Caudal 2.8 in the head, pectorals 1.3; origin of the anal a little in front of the gill-opening.

Ground-color dark golden brown, darker dorsally; scales, anal rays, and parts of the head outlined with dark brown; upper parts of the head and back, also a spot at the origin of the lateral line, almost black; cheeks brown with numerous

[8] Type, Amatuk, 138. Cotypes, Amatuk, 140, 141. Cotype, Warraputa, 147. Cotype, Konawaruk, 130.

minute yellowish dots; lips, the openings of the mucous canals in mid-dorsal region, the anus, and a small spot at origin of caudal, yellowish; fins hyaline.

Distribution: Essequibo basin, British Guiana.

25. **Porotergus gimbeli** sp. nov.[9] (Plate XXIII, fig. 3.)

Porotergus gimbeli Ellis, in Eigenmann, Freshwater Fishes of British Guiana. Mem. Carnegie Mus., Vol. V, 1912, 441.

3197 C. M., type, 200 mm. Pará, Jan. 22, 1910, Haseman.
3198 C. M., cotypes, two, 170–240 mm. Pará, Jan. 22, 1910, Haseman.
Cotype, one. Hubabu Creek, B. G., Oct. 1, 1910, Ellis.

Head 8.5 to 10.25; greatest depth of the body 8.25 to 9 in the length to the base of the caudal; anal rays, type, 175; cotypes, 178, 167, 180.

Snout 3 to 3.6, interorbital 4 to 5 in the head; eye 3 to 3.5 in the snout, 2 to 2.8 in the interorbital and 11 to 14 in the head; lateral line prominent, extending out on the caudal. Snout rather short and blunt; mouth moderately large; jaws equal when closed; the lower included; teeth small, conical and few in each jaw; eyes small.

Body and head compressed, body rather elongate; width of the head 2.5 to 3.1, depth of the head in the occipital region 1.3 to 1.6 in the greatest depth of the body; anus on the vertical from the eye; scales moderately large and prominent; a mid-dorsal band extending to the end of the dorsal filament with numerous mucous pores and without scales; dorsal profile very weakly convex or almost straight; ventral profile somewhat convex.

Caudal fin 1.8 to 2.5, pectorals 1.2 to 1.5 in the head; origin of the anal the diameter of the eye or a little more in front of the vertical from the gill-opening; scales extending well out on the caudal.

Ground-color rather light yellowish brown; dorsal portions, especially the naked dorsal band, overlaid with dark brown; most of the scales somewhat outlined with brown; ventral parts lighter; a series of oblique blackish brown stripes alternating with the anal rays extending dorsad from the edge of the anal base about half way to the lateral line; mouths of the mucous pores and the under parts of the head a clear, pale yellow or buff; anal hyaline; pectorals hyaline to dusky, the first two or three rays usually distinctly brown; caudal base whitish, the scaled portion of the caudal almost black, the outer margin hyaline.

Distribution: Lower Amazon and British Guiana.

A specimen, No. 2972, from Santarem, 190 mm., with head 7.5, snout 3; A. 175, probably belongs here.

[9] Named for Mr. Jake Gimbel, whose generosity made the Gimbel Expedition to British Guiana possible.

XV. Sternarchogiton Eigenmann and Ward.

Sternarchogiton Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 164, 1905.

Type, *Sternarchus nattereri* Steindachner.

Distinguished by the absence of teeth in the upper jaw, otherwise like *Sternarchus*.

A genus of a single species.

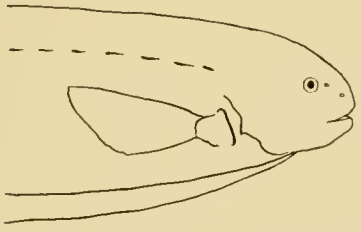


Fig. 16. *Sternarchogiton nattereri* (Steindachner).

26. Sternarchogiton nattereri (Steindachner).

Sternarchus nattereri Steindachner, Die Gymnotidæ, 3, pl. II, fig. 1, 1888 (Barra do Rio Negro); Günther, Cat., VIII, 3, 1870; Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62; Boulenger, Trans. Zoöl. Soc., XIV, 427, 1898 (Rio Jurua).

Sternarchogiton nattereri Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 165, 1905 (Barra do Rio Negro; Jurua); von Ihering, Os Peixes do Brazil, Part 1 A, 1907; Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Barra do Rio Negro).

"Length of the head about 12, depth of the body a little more than 8 in the total length; snout 3.5, pectoral 1, the caudal about 2 in the length of the head; anal rays 197; the pointed pectoral with 16 rays; the almost completely scaled caudal with 18 or 19 rays. Scales of the lateral line and the neighboring ones larger than the others.

"Upper jaw without teeth, those of the lower small and in a single row." (After Steindachner.)

Distribution: Middle and Upper Amazons.

XVI. Adontosternarchus genus nov.

Type, *Sternarchus sachsi* Peters.

Distinguished from all other *Sternarchinæ* by the absence of teeth from both jaws, and by the peculiar V-shaped groove in lower jaw into which the beaklike upper fits.

A genus of a single species, *A. sachsi*.

27. **Adontosternarchus sachsi** (Peters). (Plate XXII, fig. 3.)

Sternarchus sachsi Peters, Mb. Akad. Wiss. Berl., 1877, 473 (Apuré); Sachs, Aus den Llanos, Berlin, 1878, 153, fig. 279; Sachs, Unters. am Zitteraal, Leipzig, 1881, 13 (Apuré); Eigenmann and Eigenmann, Proc. U. S. Nat. Mus., XIV, 1891, 62.

Sternarchogiton sachsi Eigenmann and Ward, Proc. Wash. Acad. Sci., VII, 1905, 165 (Orinoco); Eigenmann, Repts. Princeton Univ. Exp. Patagonia, III, 1910, 448 (Orinoco).

3199 C. M., six, 110–170 mm. San Joaquim, Sept. 5, 1909, Haseman.
3200 C. M., fifty-one, 95–125 mm. Santarem, Dec. 12, 1909, Haseman.

Head 8.25 to 10, greatest depth of the body 7.8 to 9.7 in the length to the base of the caudal; anal rays, 154, 156, 168, 170, 176, 185.

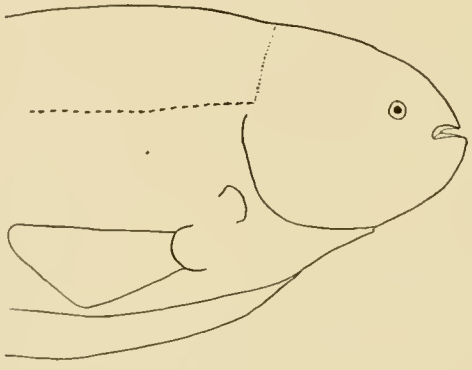


Fig. 17. *Adontosternarchus sachsi* (Peters).

Snout 3.2 to 3.5 in the head; interorbital equal to or very slightly longer than the snout; eye 2.75 to 3 in the snout, about 11 in the head.

Body moderately elongate; head compressed; width of the body 3.25 to 3.75; depth of the head 1.3 to 1.6 in the greatest body depth; anus about the length of the snout behind the vertical from the eye; dorsal profile almost straight; ventral profile rather regularly convex.

Snout pointed, quite short and curved downward; mouth rather small; gape moderate, bow-shaped and just reaching the vertical from the posterior nares; nares prominent, anterior about midway between the eye and tip of the snout, posterior not quite touching the upper anterior margin of the eye; upper jaw included, lower projecting very slightly and having a distinct V-shape notch in its center for the reception of the upper jaw, its lateral edges flare upward; scales small, larger in region of lateral line.

Caudal, which is scaled for some distance out from the base, 1.8 to 2.3, pectorals 1 to 1.4 in the head; origin of the anal on or a little in front of the vertical from the gill-opening.

Ground-color brownish gray to light yellow; body rather uniformly colored with minute dark brown dots, which are most abundant dorsally; fins hyaline, except the origin of the caudal and the outer edge of the extreme caudal portion of the anal; these regions smoky.

This species is found in the Orinoco, the Madeira, and Amazon.

Geographical Distribution.

The *Gymnotidæ* are restricted to the fresh-water of portions of Central and South America. They range from the Rio Motagua in Guatemala to the Rio de la Plata, east of the Andes. They are also found on the western coast of Colombia and Ecuador. The distribution of this family is given in the table according to river-systems. The "Lower" Amazon includes the main Amazon stream up to Manaos, the Rios Tapajos, Xingu, Tocantins and their tributaries; the "Middle" Amazon is applied to the Amazon stream from Manaos to the mouth of the Içá, Rio Negro, Jurua, and their tributaries. The Rio Madeira, although a part of the Lower Amazon system, is considered separately, as it is through this river and its branches that the Amazon fauna has probably reached the Paraguay-Paraná.

Species.	Central America.	West Indies.	Rio Magdalena.	Rio Orinoco.	Guianas.	Lower Amazon.	Middle Amazon.	Maraüon, Upper Amazon.	Rio Ucayale, Peruvian Amazon.	Ecuador, West Coast.	Brazil, North Coast.	Rio San Francisco.	Uruguay and Brazil Southeast Coast.	Rio Madeira.	Rio Paraguay.	Rio Parana.	Rio de la Plata.
1. *Electrophorus electricus* (Linn.)				×	×	×	×				×			×			
2. *Gymnotus carapo* Linn.	×	×		×	×	×	×	×			×	×	×	×	×	×	×
3. *Sternopygus macrurus* (B. and S.)			×	×	×	×	×	×	×	×	×	×	×	×	×	×	
4. *Sternopygus obtusirostris* Steind.							×				×			×			
5. *Eigenmannia macrops* (Boulenger)					×												
6. *Eigenmannia virescens* (Val.)			×	×	×	×	×	×				×	×	×	×	×	×
7. *Eigenmannia troscheli* (Kaup)						×	×	×						×			
8. *Steatogenys elegans* (Steindachner)					×	×	×										
9. *Hypopomus brevirostris* (Steind.)			×		×	×						×	×	×	×		×
10. *Hypopomus artedi* (Kaup)					×	×					×		×	×	×		×
11. *Rhamphichthys rostratus* (Linn.)				×	×	×	×	×	×					×	×		×
12. *Gymnorhamphichthys hypostomus* Ellis					×									×		×	
13. *Sternarchorhynchus oxyrhynchus* (M. and T.)					×	×	×	×									
14. *Sternarchorhamphus mülleri* (Steind.)						×											
15. *Sternarchorhamphus macrostomus* (Günther)								×									
16. *Orthosternarchus tamandua* (Boulenger)							×										
17. *Sternarchus albifrons* (Linn.)				×	×	×	×	×	×					×	×	×	
18. *Sternarchus brasiliensis* Reinhardt												×					
19. *Sternarchus leptorhynchus* Ellis					×												
20. *Sternarchus hasemani* Ellis						×											
21. *Sternarchus bonaparti* Castelnau						×	×		×					×			
22. *Sternarchella schotti* (Steind.)						×	×		×								
23. *Sternarchella balænops* (Cope)									×								
24. *Porotergus gymnotus* Ellis					×												
25. *Porotergus gimbeli* Ellis					×	×											
26. *Sternarchogiton nattereri* (Steind.)							×										
27. *Adontosternarchus sachsi* (Peters)				×		×								×			
Total	1	1	3	7	15	17	14	8	6	1	4	5	5	13	7	5	5

Three species, *Gymnotus carapo, Eigenmannia virescens* and *Sternopygus macrurus* are found throughout almost the entire range of the family. Four others, *Hypopomus brevirostris, Hypopomus artedi, Rhamphichthys rostratus* and *Sternarchus albifrons,* have an almost equally wide distribution. The remaining species are confined largely to the Amazon system and the Guianas. Twenty-four of the twenty-seven species are found in some part of the Amazon system and fifteen species are listed from the Guianas. The combined Amazon and Guiana faunas include all of the species of the family with the single exception of *Sternarchus brasiliensis.* This species is known only from the Rio San Francisco and its tributaries and is restricted to the higher parts in the region of the Sierra Matta da Corde.

The *Gymnotidæ* are largely lowland fishes as is shown by the steady decrease in the number of species as the Amazon is ascended. This of course may be due in part to incomplete exploration. In places when the faunal survey has been quite complete, however, they are largely found in the lowland. Of the fifteen species known from British Guiana all are found in the lowland, while but two, *Gymnotus carapo* and *Eigenmannia virescens,* have been taken on the plateau.

Locomotion and Musculature.

I. *Locomotion.*

The method of swimming, particularly the use of the long anal fin, of the *Gymnotidæ* has been discussed several times. No final conclusion has been reached, however. In 1774 Alexander Garden described the method of swimming of the electric eel. He worked at Charleston, S. C., with five specimens which had been shipped him from Surinam. The motion of the fish, according to Garden, was the result of an undulating movement of the anal fin. This has subsequently been shown to be correct by Sachs. Unfortunately Lacépède misquoted Garden in his "Histoire Naturelle des Poissons" published in 1800, by ascribing the undulating motion not only to the anal fin but to the body of the eel as well. As a result of this the exact use of the anal fin remained in doubt until the careful work of Sachs (Zitteraal, 1881). He described the swimming of the electric eel in detail as follows:

"Die Zitteraale sind ausnehmend gewandte Schwimmer und zwar schwimmen sie gewöhnlich nicht durch Schlängeln des Schwanzes, wie Lacépède annimmt, sondern einzig und allein unter Anwendung der weichhautigen, dem Kiel eines Schiffes gleichenden Afterflosse, welche durch die Brustflossen in geringemgrade unterstützt wird. Die Bewegung der Afterflosse besteht in einer wellenförmigen Schlängelung; läuft die Wellen von vorn nach hinten so wird der Fisch vorwärts bewegt, läuft sie umgekehrt, so schwimmt er rückwärts; die Bewegung ist geradlinig oder bogenförmig, je nachdem der Körper des Fisches ausgestreckt oder gekrümmt ist" (p. 104, l. c.). Sachs neglected to observe the method of swimming of the

other *Gymnotids* and was unable to say whether the method described for *E. electrophorus* was common to all.

In his phylogenetic-ethologic study of the *Gymnotidæ*, Schlesinger (1910) states that the use of the anal fin described by Sachs must be general throughout the family. He bases his conclusion entirely on a morphologic comparison between the Mormyrid *Gymnarchus* and the Gymnotids *Electrophorus* and *Gymnotus*. In a footnote he adds that Dr. Franz Steindachner told him that he had seen living Gymnotidæ in Brazil swimming in the method described.

While in British Guiana in the summer of 1910 I had opportunity to study the motion of a number of species in their normal environment. Three species in particular were examined, *Eigenmannia virescens* and *Sternopygus macrurus*, which are abundant in the trenches in and about Georgetown, and *Gymnotus carapo* in Hubabu Creek. Several other species were also seen alive. In every case two methods of swimming were observed, (1) the use of the anal fin alone, and (2) the use of the anal aided by the body proper or the pectorals or both.

When at rest the Gymnotids face the current of the stream, the entire body and caudal appendage being in a straight line and the pectorals laid back against the body. The anal fin was kept moving just enough to counteract the motion of the stream, and the pectorals gave an occasional stroke. The movements of the anal fin were similar to those described by Sachs for the electric eel. From the cephalad end of the anal fin a series of undulating waves passed caudad so that a longitudinal section of the entire anal fin in motion resembles a fairly regular sine curve. There were usually six of these waves traversing the fin at any one time, rarely five or seven. The speed of the wave varies with the speed of the current of the stream—always being just sufficient to maintain the position of the fish. If the current varied in direction the fish responded at once with a stroke of one or both of the paddle-shaped pectorals, which kept the long axis of the fish parallel to the direction of the current. Otherwise the pectorals were not used. During these resting periods the caudal appendage streams out behind the fish.

If a resting fish were slightly disturbed it merely increased the speed of the waves traversing the anal and moved away. If frightened (all of the *Gymnotidæ* were very easily frightened) it swam rapidly away by the same motion of the anal fin, the use of the pectorals being more frequent in guiding the fish. If it became necessary for the fish to make a sudden turn, the entire body was slightly curved in the desired direction. This curving of the body together with the rapid use of the pectorals enables these long fishes to make quite abrupt turns.

The second method of swimming involved the use of the entire body as well as the fins. When the fish was being pursued, the anal fin moved, as before, in a series of rapid waves, but in addition the entire body was at the same time moved in a serpentine fashion. In this way it was able to swim very rapidly. An individual would move the anal fin rapidly in the peculiar manner of swimming when held in the air.

While experimenting with these fishes the caudal appendage of several was removed. This seemed in no way to influence the speed or method of swimming. When a large portion of the anal fin was cut off the fish swam by means of the pectorals. If the pectorals alone were removed, the fish swam by the use of the anal fin and body motion together. This was probably due to an effort to guide itself, since the guiding is done almost entirely by the pectorals. The anal could be used for either backward or forward movement.

II. *Anal Musculature.*

The muscles moving the anal fin, the muscles *pinnalis analis externalis* and *pinnalis analis internalis*, together with the muscles *lateralis imus* and the *interhæmal* spines compose the thin compressed region just above the anal fin. These muscles, as well as the *interhæmal* spines, are directed ventro-caudal at an angle of five to ten degrees to the long axis of the fish, hence in a cross-section of the body the obliquely cut ends of several show in the anal region. There is a pair of *pinnales analis externalis* and *pinnales analis internalis* for every anal ray. The *externales* are the larger of the two. These muscles have their origin in the skin on each side and their insertion on a lateral process on each side of the *dermohæmal* spine (anal ray). The *internales* arise from the dorsal portion of the *interhæmal* spine and are inserted on the top of the *dermohæmal* spine on each side of its articulation with the *interhæmal* spine. The *interhæmal* spine is a slim, straight bone, with its dorsal end pointed. On its ventral end it bears an enlarged rounded head, and two smaller knobs a little lower down. These knobs lie in the median cephalo-caudal line. The *dermohæmal* spine has a cup-shaped articulation on its dorsal end which fits around these three heads of the *interhæmal* spine in the nature of a ball and socket joint. The presence of the two small heads on the *interhæmal* spine in the cephalo-caudal line allows the *dermohæmal* spine only a limited motion in that direction, but a free movement laterally. The undulating movement of the anal fin results from the alternate contraction of the right *internalis* and *externalis* and then the left. Fig. 18 shows the anal musculature of *E. viresceus* on a large scale. The muscles may be seen in Plate XIX, figs. 19, 20, 21, 22, 23, which are entire cross-sections. In the cross-sections, however, the anal musculature is drawn in the same plane as the trunk musculature and the ventro-caudal slope is disregarded, so that the entire muscle may be seen.

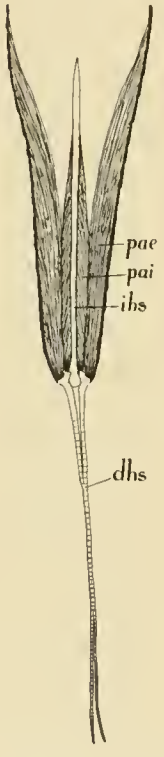


Fig. 18. Anal musculature. *Eigenmannia virescens* (Val.) *pae, pinnalis externalis; pai, pinnalis analis internalis;* ihs, interhæmal spine; dhs, dermohæmal spine.

III. *Trunk Musculature.*

The disposition of the muscles in the trunk is much the same for all species of the *Gymnotidæ,* although the individual muscles vary in size and shape with the presence or absence of the pseudo-electric organs. The trunk muscles are all paired, one on each side of the median line. Naming them in order dorsoventrally they are, *notalis externalis, notalis internalis, dorsalis, lateralis superior, lateralis inferior, ventralis,* and *lateralis imus.* The nomenclature of Fritsch is followed as far as given, *notalis* is a new name. (See Plate XIX, figures 19, 20, 21, 22, 23.) The region near the dorsal end of the *interhæmal* spine, which is not occupied by other tissue, is filled with fat cells and connective *tissue.* On Plate XIX, fig. 20, the pseudo-electric organs are to be noted.

Electric Organs of the Gymnotidæ.

I. *Electrophorus electricus* (Linnæus).

The electric eel is the only species of this group which has been demonstrated to possess electric power. Richter in 1729 published the first scientific account of this species in the Paris Academy. His account was soon followed by many others. The earliest English description of this fish is that of Edward Bancroft in his "Natural History of Guiana," 1769. This contains an interesting account, which is here quoted:

"There is one, however, of the Eel tribe which deserves particular attention, and which I shall beg leave to call the Torporific Eel, till it is distinguished by a more proper name.

"This fish is a native of fresh water and is most commonly found in the River Essequibo, being usually about three feet in length, and twelve inches in circumference near the middle. It is covered with a smooth skin of a bluish lead color, very much like that of sheet lead which has been long exposed to the weather, being entirely destitute of scales. The head equals in size the largest part of the body, but is somewhat flat on the upper and lower sides, and its upper surface is perforated with several holes, like those of a Lamprey Eel. The upper and lower jaws extend in equal distance, terminating in a semi-oar-shape, and forming a wide mouth without teeth. On the back part of the head are two small fins, one on each side, much like the ears of a horse, are either elevated or depressed as the fish is pleased or displeased. From about eight inches below the head, the body gradually diminishes in size to the tail, which ends in a point, without a fin. Under the belly is a fleshy fin, about half an inch in thickness and near three inches wide, extending from the head to the point of the tail, but diminishing in width as the body diminishes in size; this, with the two fins on the head are all that I found on the body of this eel, which would be nearly round if deprived of the belly fin. This fish frequently respires and elevates his head above the surface of the water every four or five minutes. But the most curious property of the Torporific Eel is

that when it is touched either by the naked hand or by a rod of iron, gold, silver, or copper, etc., held in the hand, or by a stick of some particular kind of heavy American wood, it communicates a shock perfectly resembling Electricity, which is commonly so violent, that but few are willing to suffer it a second time" (p. 190 *et seq.*).

This is a fair description of the eel and its shock. The most noticeable error in Bancroft's statement is that the eel is toothless. As soon as it became rather generally known that this fish actually possesses the power of giving a severe shock, it was taken up by quacks of all sorts. Several doctors in the Guianas at once claimed remarkable cures to have resulted from the proper use of the electric eel. One man in particular, Van der Lott of Georgetown, was especially active in urging the use of the electric eel in the treatment of disease. Various other people from time to time have suggested this use and even today there is an idea extant that a piece of the electric eel's skin, worn about the limb affected, will remove rheumatism. Many of the accounts of the electric eel relate strange tales of its uses and properties. The story of Humboldt has become classic. This represented the Indians driving horses into the pool inhabited by the electric eels which were eventually caught as they floated on the surface after having exhausted themselves by shocking the horses. Sachs relates the use of the dried vertebræ of the eel by the Indians in childbirth. He also states that the belief is current that a cock once shocked by an electric eel is capable of shocking anything else for the remainder of the day; that persons chewing tobacco are immune from being shocked; and that a person shocked in the leg is apt to become permanently lame.

With the advances in science the electric fishes were more carefully investigated and among those who studied the electric eel was Faraday. He gave the first accurate estimate of the power and nature of the shock of this fish after experimental work with a 101.6 cm. specimen in captivity at the Adelaide Gallery. He found an average shock from this fish to be equal to that from a battery of fifteen Leyden jars with a surface of 2.258 square meters loaded to their maximum (p. 8, Exp. Researches).

In 1876–9 Dr. Carl Sachs made a series of observations and experiments upon the electric eel in its natural environment. This work was done in Venezuela on the Rios Apuré and Orinoco. Unfortunately, he lost his life shortly after his return to Europe, before he had worked up his valuable data. Bois-Reymond published his notes in 1881 in "Untersuchungen am Zitteraal" (Leipzig). The following discussion of the electric eel is based in part on this book.

1. *Anatomy.*

There are three pairs of electric organs in *E. electricus*, the large electric organs, the secondary organs or the organs of Hunter, and the bundles of Sachs. The large organs and the organs of Hunter both begin a short distance behind the viscera and run nearly the whole length of the fish. The bundles of Sachs are

found only in the posterior half of the fish. The large organ of each side is more or less quadrant shaped in cross-section, and is of greatest diameter about a centimeter back of its origin. It tapers gradually back of this point becoming more nearly circular in cross-section until it disappears a few centimeters from the end of the tail. It lies on each side of the hæmal spine above the anal fin musculature and below the muscle *ventralis*. In the region of its maximum size the top of each organ is on a level with the vertebral centra, but as the caudal end is approached, the dorsal portion of each organ lies more and more ventrad.

The organ of Sachs consists of a series of bundles of fibers which resemble both muscle and electric tissue. From the middle of the body to the caudal end of the large electric organs, the organs of Sachs lie on the *dorso-lateral* surface of the latter, just below the muscle *ventralis*. The bundles of this organ wrap around the large electric organ obliquely in a latero-ventral direction. They extend farther ventrad as the caudal extremities of the large organs are neared. They finally close over the ends of these. The organs of Sachs increase in diameter caudad.

The organs of Hunter are triangular in cross-section and much smaller than either of the other two pairs of organs. They are in the anal fin region and lie between the muscles *pinnalis analis externalis* and the muscles *pinnalis analis internalis*. Dorsally they are separated from the large organ by the remnants of the muscles *lateralis imus*. They taper off as their caudal ends are approached and terminate a few centimeters in front of the ends of the large organs. Plate XIX, figs. 21, 22, 23 represent cross-sections of the electric eel showing these points.

Both the large organs and the organs of Hunter are composed of plates of tissue which run parallel to the large axis of the fish. In the large organs these plates are more or less arched ventrally in cross-section. In the small organs they are almost flat. The number of these plates seem to be rather constant in each organ, regardless of the size of the fish. Bois-Reymond (in Sachs, Zitteraal, p. 32) gives the following table:

Observer.	Body Length.	Plates in Large Organ.	Plates in Small Organ.
Sachs	31 cm.	30	14–19
Knox	48.5	32	17
Pahlberg	68.5	32	13
Hunter	71	35	15
Kupffer and Keferstein	120	31	Not given
Humboldt	Not given	36	20
Sachs	Not given	30	14–19

According to Sachs, who confirmed in general the work of Pacini, the large electric organs are made up of minute units about .14 mm. broad, which lie at right angles to the long axis of the plates. Each unit is divided near the center by a vertical partition. On the anterior face of this are several papillæ which do not reach the wall of the unit. On the posterior face are fewer papillæ which reach out to the wall of the unit. Between the latter are several minute papillæ. It is

on this side that each unit receives its nerve-fibers. It is not, however, intended here to discuss the microscopic structure.

Aside from the electric organs the anatomy of the electric eel is very similar to that of the other *Gymnotids*.

2. *Nature and Strength of Electric Shock.*

Sachs states that the electric shock may be received in four ways.

1. By completing an electric arc.
2. By conduction.
3. Direct contact.
4. From the water in which the eel is discharging shocks.

1. Sachs considers an arc to be completed if the electric eel is touched at two points. He found the maximum shock was received when the connections were made just behind the head and at the end of the tail. This of course included the entire mass of electric tissue. Sachs accidentally made such an arc with an eel three and one-half feet long. Its head fell on one foot and its tail on his other leg. The contact lasted for about thirty seconds, during which time Sachs was unable to move. He experienced great pain the rest of the day and soreness of the limbs for some time afterward. Humboldt tells of stepping on a four foot eel in such a way as to make a head and tail connection and being instantly knocked down by the shock received. Dr. Eigenmann relates that all of the fishes taken in a haul of a large seine were killed by an electric eel, which was among the catch, while the seine was being pulled in. The experiments of Sachs showed that the strength of the shock varied directly with the amount of the electric tissue included in the arc.

2. and 3. Direct contact in but a single place on the fish is also capable of transmitting a shock, if the ground completes the circuit. A severe shock can be received if the eel is only touched by a finger. In the same way the shock can be inflicted through wet wood, cordage, metal, or any other conductor. Glass and rubber are insulators against it.

4. The limit of the effectiveness of the shock in water has never been determined. Sachs gives several cases of the transmission of the shock in this way. Mules are often knocked from their feet while fording small streams frequented by the eels, without actually being struck by them. Natives attempting to get out of a boat into the water are frequently unable to get either in or out after touching the water if an eel is near by, until the shock ceases. On account of such occurrences the natives regard these eels with great fear and hatred, killing them when opportunity offers. While experimenting with eels in wooden troughs, Sachs found they were able to kill frogs, fishes, and freshwater shrimps (contrary to the idea that the last mentioned form is immune) at a distance of several feet.

A careful count of the number of shocks given by a single eel was made by

Sachs. During one hour this eel gave 150 distinct shocks and by actual measurement the last was as strong as the first. Humboldt stated that after a few shocks the eel became exhausted and it took both food and rest to recuperate its electric power. Sachs found no evidence of such a condition.

The shock of the electric eel readily decomposes potassium iodide, as has been shown by its effect on potassium iodide starch-paper.

3. *Origin of Electric Organs.*

Fritsch concluded (Sachs' Zitteraal, 355 *et seq.*), after a comparison of the musculature of electric eels and the other *Gymnotids*, that the large electric organs have originated through the metamorphosis of the *lateralis imus* muscles. This view is substantiated in several ways. The muscle *lateralis imus* occurs on both sides of the median line in the other *Gymnotids* in precisely the position occupied by the large electric organs in the electric eel, in which this pair of muscles are wanting. Along the ventral side of each of the large electric organs is a small strip of muscular tissue, which is continuous with the electric plates. This is probably an unmetamorphosed remnant of the muscle *lateralis imus*. The origin of Hunter's and Sachs' organs has not been definitely worked out. The remaining musculature is the same in all *Gymnotids*. It is known that the electric organs of several of the other electric fishes (*Torpedo, Malopterus*, etc.) are metamorphosed muscle tissue.

II. *Eigenmannia virescens* (Valenciennes).

Sachs (*l. c.*, p. 69) recorded in his notes an observation on pseudo-electric or electric tissue in *Sternopygus* (*Eigenmannia*) *virescens*. As this portion of the notes was not worked up before his death it is not clearly understood. He wrote:

"Der dem electrischen Organ von *Gymnotus* entsprechende Theil zeichnet sich durch regelmässige Streifung in Zwischenräumen von 1 $^{mm.}$ aus. Der Durchschnitt hat ein entschieden an *Gymnotus* erinnerndes Verhalten. Die betreffende Stelle (a) ist durchscheinend und von horizontalen Septis durchzogen, Die mikroskopische Untersuchung fällt wegen der Schwierigkeit des Gegenstandes ungenügend aus. Es werden jedoch Formelemente, etwa ähnlich dem Durchschnitt der Platten von *Malopterurus*, mit runden Kernen und einfach buchend, nachgewissen. Andererseits finden sich gewaltige Mengen dicker markhaltiger Nervenfasern mit reichen büschelförmigen Verzweigungen. Der Zusammenhang der (etwaigen) beiden Elemente aufzuklären gelingt aber nicht in befriedigender Weise."

This is accompanied by a figure which is reproduced in Plate XIX, Fig. 24. Fritsch, after a careful examination of specimens of this species, doubts the existence of these elements. The region marked "α" by Sachs was occupied, in the specimens I examined, by connective tissue fibers and the edge of the two lateralis muscles. *Eigenmannia virescens* is the only other *Gymnotid* besides *E. electricus* to which electric tissue has been ascribed.

III. *Steatogenys elegans* (Steindachner).

In the original description of this species Steindachner[10] notes a pair of cylindrical filaments which lie in grooves on each side of the mental region and a second pair of skinny flaps, one of which projects from a groove on each side above the pectorals. Boulenger[11] placed this species in a separate genus because of these peculiar filaments. Neither of these pairs of filaments has been studied farther, since very few specimens of this species have been collected.

Specimens of this species in the collections made by Dr. Eigenmann and by Mr. Haseman make a detailed study of these filaments possible, and subsequently I obtained six specimens while in British Guiana. Only a short account of these organs is given here, as they are to be more fully described in a separate paper.

The mental filaments begin near the lower margin of the pectorals, curving downward and inward until the middle of the mental region is reached. They terminate side by side about two millimeters from the edge of the lower pair. Each filament is covered for its entire length, except at its termination, by a thin transparent membrane. About a millimeter from the tip of each filament this membrane separates, leaving a median, oval area exposed. In preserved specimens this membrane may easily be torn and the entire filament lifted out of the containing groove to its attachment below the pectoral. The filaments are about twelve millimeters long and half a millimeter in diameter. In life they are transparent, but when preserved they become fatty in appearance and show numerous opaque cross-bands. These bands are plate-like structures, which cross the cylindrical filaments at about right angles, and on both surfaces bear small papillæ. The plates in the specimens so far examined vary in number from sixty-eight to eighty in each filament. On the proximal (i. e., dorsal) edge of each filament a large nerve runs the entire length of the filament and distributes its fibers to the plates. The space between the plates is crossed about midway by a very delicate partition. The lateral filaments, called skinny flaps by Steindachner, are much like the mental filaments. Each lies in a groove, which begins just above and behind the origin of the pectorals and curves upward and backward from its base, a thinner portion extends downward behind the pectorals to the origin of the ventral filament. The histological structure of these filaments shows many points of similarity with that of the electric tissue of the electric eel. For the present, at least, these structures are considered as electric, or pseudo-electric, organs.

IV. *Other Pseudo-electric Organs.*

A paired organ made up of long fibers was found in *Sternarchus albifrons* (Linnæus) and *Sternarchus hasemani* sp. nov., running from just behind the viscera to about the middle of the caudal region. The two halves of this organ lie in the

[10] Steindachner, Fish-Fauna Cauca-Guayaquil, 1880, p. 37.

[11] Boulenger, Trans. Zool. Soc., Lond., XIV, 1898, p. 428.

* A Study of the Submental Organs of *Steatogenys elegans*, etc., by Annie Lowrey. *In press.* Miss Lowrey finds the submental organs to agree histologically with the electric tissues of *E. electricus*.

center of the animal just below the *lateralis inferior* muscles and above the *ventralis* muscles. In cross-section each half is roughly trapezoidal and about the size of the muscle *lateralis inferior*. Macroscopically these two masses resemble electric tissue. Their histological structure is to be discussed in another paper.

Two other much smaller bundles of tissue, which did not seem to be muscles, were found between the muscles *ventralis* and *imus* near the median line, not only in *Sternarchus albifrons* and *Sternarchus hasemani*, but also in *Gymnotus carapo* (Linnæus) and *Adontosternarchus sachsi* (Peters).

These bundles were not so clearly defined as the first mentioned organs, and may be nothing more than muscle fibers. See Plate XIX, Fig. 20.

Food of the Gymnotidæ.

References to the food of this group of fishes are few. Specific records were found only for the electric eel. Kaup, in 1856, made a general statement concerning the probable food of the fishes of the genus *Rhamphichthys* and from time to time statements have been made concerning the food of the electric eel. Schlesinger has recently speculated on the probable food of this group. His speculations are based on the similarity of species of the *Gymnotidæ* and the *Mormyridæ*.

Since large numbers of specimens of several species were available, a study of the contents of their stomachs was undertaken. The large number of specimens permits a detailed study of the food of *Gymnotus carapo, Sternopygus macrurus, Eigenmannia virescens* and *Eigenmannia macrops*. The data for the other species are rather incomplete. The stomach-contents were washed into Petri dishes with alcohol. All of the large pieces were picked out and identified. The residue was then taken up with a pipette and examined under the microscope on an ordinary glass-slide, on which four pieces of glass had been cemented to form an alley a little narrower than the field of the microscope. The results of the examinations are tabulated for each species. In several of the tables the terms, "Insect debris," "Vegetable debris," occur. No attempt was made to identify the vegetable matter. The "insect debris" is a mass of parts of insects which could not be identified with certainty. On the whole the stomachs were found either quite empty or containing a large mass of food, little, if at all, mangled. Only a few of the stomachs contained partly digested food. Examination of the intestines showed digestion to be quite complete, for chitinous parts of insects and fragments of the calcareous portions of macro-crustacea were the only undigested material found among the otherwise soft intestinal contents.

Gymnotus carapo Linnæus.

Snout short, heavy and blunt; conical teeth in both jaws; mouth large; size, not exceeding 500 mm.

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Annelida.	Malacostraca.	Fishes.	Vegetable Debris.
1	Holmia	430						1		
2	Aruataima	410						2		
3	Aruataima	320						1		
4	Nickaparoo	300						1		
5	Nickaparoo	250						1	1	
6	Trementina	250						1	1	
7	Aruataima	240		1				1		*
8	Nickaparoo	235		4		*				
9	Holmia	230		3				1	1	
10	R. das Velhas	225		1						
11	Aruataima	222		11			1	1		
12	Aruataima	200		3		*				
13	R. das Velhas	180		15	1					*
14	Nickaparoo	180		13		*		1		
15	Entre Rios	175		20		*				
16	Holmia	172		22						
17	Holmia	170		10		*				
18	Holmia	165		7		*				
19	Packeoo	160	3	7						
20	Packeoo	160	13							
21	Holmia	120		3						
22	Nickaparoo	100								
23	Tukeit	100	5	16						
24	Packeoo	90	6							
25	Entre Rios	90	9							
	Total		36	136	1		1	11	3	

It will be seen from the preceding table that a correlation exists between the kind of food taken and the size of the eel. The twenty-five specimens may be divided into three groups. The first of these groups includes all of the specimens between 240 mm. and 430 mm. in length. These fed almost entirely upon large crustacea and fishes, only a few insects having been eaten by three of the smaller ones. Of the eleven malacostraca one was an Isopod, the rest freshwater shrimps. Two of the three fishes found were small Characins; the third, which was found in the stomach of No. 4, was a *G. carapo* 90 mm. in length. The second group, those specimens between 100 and 240 mm. in length, contained little else than insect larvæ. The larvæ of Diptera and of Trichoptera of several species were especially abundant. Of the one hundred and thirty-six insect larvæ found eighty-one were Diptera, twenty-seven Trichoptera, six Odonata, and twenty-three uncertain. The Dipterous larvæ resemble the larvæ of *Simulium* in general shape and size. The Trichopterous larvæ, which had been swallowed with the case uncrushed, were forms whose cases were made of small particles of sand, some being straight, others cochlear in shape. Only fishes under 100 mm. in length had eaten Entomostraca. These had also taken small parts of insect larvæ. The single adult insect found was a medium sized cricket, the one worm a small Oligochæte.

Summarizing: The small specimens had fed upon Entomostraca and insect larvæ, those of medium size upon the larvæ of insects and large crustacea, the largest upon large crustacea and fishes. One individual was a cannibal. None of the food was from the air, the land, or the surface of the water; a large per cent of

it was free-swimming. It is probable therefore that most of the food is taken while it is moving.

ELECTROPHORUS ELECTRICUS (Linnæus).

Snout moderate and blunt; conical teeth in both jaws; mouth large; size up to seven feet.

No stomachs of this species were examined. From the references given below its food seems to consist for the most part of small fishes and freshwater shrimps. The data are for large eels only and in two or three instances show the kinds of food which is taken when in captivity, rather than the normal food as chosen by the free fish. The authority is stated and followed by the food mentioned.

Sachs, Zitteraal, p. 108: "especially freshwater crustacea, also small fish, small crayfish, many insects, and grasshoppers."

Flagg, Trans. Am. Philos. Soc., Vol. ii, p. 172: "Its common food is shrimps or any small fish."

Garden, Trans. Am. Philos. Soc., 1775, p. 110: "Small fish, also any animal food if it is cut so they can swallow it."

Faraday after Humboldt, Experimental Researches, 1753, p. 3: "Boiled meat and bread, small fish."

Sachs, *l. c.*, 110: "Nothing dead, except dead fish."

STERNOPYGUS MACRURUS (Bloch and Schneider).

Snout rather blunt; minute teeth in patches in both jaws; mouth moderately large; size, up to 500 mm.

Sternopygus macrurus (Bloch and Schneider).

The contents of twenty-nine stomachs of this species were examined. Three items are found distributed in the table much as in the table given for *G. carapo*, namely: fishes, malacostraca, and entomostraca. The first two were eaten only by the fish above 290 mm. in length, while the last named were only in the stomachs of specimens less than 100 mm. in length. The most noticeable difference between the food of *G. carapo* and *S. macrurus* is the amount of insects consumed by the latter. Adult insects form the major portion of the food, not only of the medium-sized individuals, but of the eels above 100 mm. long. Four hundred and three adult insects were counted, of which three hundred and twenty-one were aquatic Coleoptera (for the most part *Gyrinidæ*); seventy-five aquatic Hemiptera (Corisidæ and Notonectidæ); four terrestrial Coleoptera (Carabidæ); three terrestrial Hemiptera (Reduviidæ and Pentatomidæ). They are all surface-forms or land-forms which could easily reach the water. The eighty-two insect larvæ were identified as follows: fifty-three Diptera; one Odonate; twenty-one Trichoptera, and seven doubtful. Seventeen fishes (Characins), one Amphipod, three Isopods, and three freshwater shrimps with fourteen entomostraca made up the rest of the food. The main food of medium-sized specimens is adult insects. In two larger indi-

No.	Length.	Locality.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Malacostraca.	Fishes.	Vegetable Debris.
1	500	Georgetown			2			1	*
2	480	Georgetown		3	15		1		*
3	450	Potaro River		5	1		1		*
4	430	R. S. Francisco				*			*
5	430	Pirapora		8	1	*			
6	410	Penedo						14	
7	400	Amatuk					2	2	*
8	400	Georgetown			1				*
9	400	Georgetown			8				*
10	380	Georgetown			46				
11	370	Georgetown		1	8				*
12	350	Aruka			1	*			*
13	340	Penedo				*			*
14	340	Georgetown			47	*			*
15	300	Potaro River		3	5	*	1		
16	290	Potaro River		13			1		*
17	270	Georgetown			95				
18	250	Georgetown	1	3	57				*
19	220	Georgetown		2	12				*
20	200	Georgetown			34	*			*
21	180	Georgetown		10	6	*			*
22	180	Georgetown			25				
23	170	Georgetown			15				
24	170	Georgetown		7	6				
25	160	Georgetown		2	9				
26	160	Georgetown	1	6	5				
27	150	Georgetown			3				
28	95	Savanah		11	1	*			*
29	60	Amatuk	12	8					
Total			14	82	403		6	17	

Eigenmannia virescens (Valenciennes).

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Hydrachnidæ.	Annelida.	Isopoda.	Vegetable Debris.
1	Wismar	270		13				20		
2	Wismar	265	1	29						
3	Georgetown	260	54	6	1					
4	Georgetown	258	19	2			4	1		
5	Maripicru	250	4	40						
6	Maciel	250			7		1	4		
7	Urugnayana	250	228	10	1	*				
8	Georgetown	240	190	8			26			
9	Hubabu	240	10	3		*	1	3		
10	Wismar	230	70	12					2	*
11	Cornmba	230		9	3				1	
12	Santerem	220		33		*	4	6		
13	Wismar	220		107						
14	Wismar	200	430	47		*				
15	Georgetown	200	361	8						*
16	Georgetown	200	71	9			17	1		
17	Georgetown	190	8	46			4			
18	Potaro	190	144	152						
19	Santerem	140	79			*				
20	Itapura	135	82		1					
21	Maciel	90	17	17						
22	Bebeduro	85		20						
23	Santa Rita	50	50	3						
	Total		1,817	574	13		57	35	3	

viduals these were supplemented by large crustacea and small fishes. As this fish is known to frequent the weeds of the small open streams and trenches, it is probable, judging from the nature of its food, that it does most of its feeding at or near the surface.

Eigenmannia virescens (Valenciennes).

Snout short and rather blunt; minute teeth in patches in both jaws; mouth small; not exceeding 300 mm. in length.

In the twenty-three stomachs examined the bulk of the food was of two kinds, regardless of the size of the fish, namely Entomostraca and the larvæ of insects. These two kinds of food exceeded all others not only in numbers but in bulk. The only kinds of food found in any amount were Hydrachnidæ and Annelida. All of the food is soft and small. The four classes of food are found distributed throughout the table, but there is a grouping with regard to the size of the fish. Over one-half of the eighteen hundred and seventeen Entomostraca were taken from specimens under 200 mm. long, and more than one-half of the insect larvæ from the specimens over 200 mm. The other kinds of food were also found in the stomachs of specimens over 200 mm. long. The young fish are restricted to entomostraca more than the adults. The insect larvæ were for the most part small Diptera, and the Annelida represented a small soft form resembling *Tubifex*.

(3) *Eigenmannia macrops* (Boulenger).

Snout short, truncated; teeth minute; in patches in both jaws; mouth quite small; size small, not exceeding 200 mm.

No.	Locality.	Length.	Entomostraca.	Insect Larvæ.	Adult Insects.	Insect Debris.	Hydrachnidæ.
1	Rockstone	175	44	3	.....	*	1
2	Tumatumari	172	17	30			
3	Tumatumari	170	9	122			
4	Tumatumari	165	40	109			
5	Rockstone	160	4	7	.....	.....	3
6	Rockstone	160	23	22			
7	Rockstone	155	42	72			
8	Rockstone	150	4	40	.....	*	
9	Rockstone	148	1	2	.....	.....	3
10	Crab Falls	144	16	34	1	.....	1
11	Rockstone	140	44	.....	.....	.....	1
12	Rockstone	140	7	.....	.....	*	
13	Rockstone	135	2	3	.....	.....	1
14	Crab Falls	135	1	4	.....	*	
15	Crab Falls	130	30	47	.....	*	5
	Total	.....	284	495	1	.....	15

Only adult specimens of this species were examined, so no comparison of the food and the size of the fish could be made. The food of this small species seemed much the same as that of specimens of *E. virescens* of the same size. Entomostraca and insect larvæ formed the bulk of it.

(4) *Eigenmannia troscheli* (Kaup).

Snout short; minute teeth in patches in both jaws; size small, not exceeding 250 mm.

The stomach of but a single specimen 180 mm. long was examined. It came from San Joaquim and contained twenty-nine Copepoda, seventeen Cladocera, three dipterous larvæ and one Hydrachnid. This food is of the same type as that taken from the two preceeding species of this genus.

(5) *Hypopomus brevirostris* (Steindachner) and (6) *Hypopomus artedi* (Kaup).

These two species are so similar that they will be considered together. Snout short, somewhat pointed; teeth wanting; mouth small; caudal appendage moderate to long; size small.

Hypopomus artedi (Kaup).

Locality.	Length.	Entomostraca.	Insect Larvæ.	Annelida.	Vegetable Debris.
Lama Stop-off	170	3	.....	2	*
Rio Jauru	145	4	25	1	*
Uruguayana	140	.....	18		
Santerem	130	.....	14	3	*
Caceres	120	.....	23	.....	*
Total		7	80	6	

Hypopomus brevirostris Steindachner.

Locality.	Length.	Entomostraca.	Insect Larvæ.	Annelida.	Vegetable Debris.
Chipoo Creek	165	14	10		
Campo Grande	140	17			
Nickaparoo	118	9	12	4	*
Itaituba	100	.....	14	7	
Boa Ventura	75	20			
Total		60	36	11	

(7) *Steatogenys elegans* (Steindachner).

Head chubby; snout short and blunt; mouth small; a cylindrical filament in a groove on each side of the mental region; size small.

This species was of particular interest because of the peculiar mental filaments. The stomachs of the specimens examined contained a large number of small annelids. These worms are small mud-inhabiting Oligochæta. The contents of the three stomachs are tabulated here:

Length.	Locality.	Entomostraca.	Insect Larvæ.	Annelida.
140 mm.	Kumaka	3	1	43
130 mm.	Kumaka	9	4	18
120 mm.	Kumaka	2	.....	29
Total		14	5	90

(8) *Rhamphichthys rostratus* (Linnæus).

Snout produced, long, and tubular; mouth quite small, terminal and inferior; teeth wanting; size large, approaching six feet.

The stomachs of three adults of this remarkable species were examined. In addition to a large amount of mud they contained 612 annelids.

Locality.	Length.	Insect Larvæ.	Adult Insects.	Annelida.	Amphipoda.
Wismar	900	33	.....	148	1
Wismar	750	9	1	214	
Wismar	580	40	.....	250	
Total		82	1	612	1

The annelids were all small mud-inhabiting worms, resembling *Tubifex*. The eighty-two insect larvæ were identified as seventy-one Diptera (a form much like the "Blood Worm") and eleven uncertain. The single adult insect was a small *Gyrinid* and the Amphipod a tiny specimen in general shape similar to *Eucrangonyx*. The small mouth of this species (in even the largest specimen examined it barely admits a lead pencil), the large amount of mud in the stomach and the nature of the food indicate that this species probably feeds by sucking up quantities of mud with the animals inhabiting it.

Kaup[12] in 1856 wrote concerning the genus *Rhamphichthys* (which then included *Hypopomus* as well): "Judging from the narrowness of their toothless mouth, these fish must subsist on small insects."

(1) *Sternarchus albifrons* (Linnæus).

Snout heavy and blunt; teeth in both jaws minute, conical; mouth large; size moderate, not exceeding 500 mm.

The stomach of a specimen of this species 285 mm. long contained one small Characin, two freshwater shrimps, and one large insect larva (perhaps a Gomphid). From the stomach of a second smaller specimen, 105 mm. long, nineteen entomostraca and three large insect larvæ were taken.

(2) *Sternarchus brasiliensis* Reinhardt.

Similar to the *S. albifrons*, but slenderer. In the stomach of an individual of this species 290 mm. long from Pirapora two small freshwater shrimps and a quantity of vegetable debris were found.

(3) *Sternarchus hasemani* Ellis.

Mouth moderate; size small; otherwise much as *S. albifrons*.

Two stomachs of this species were examined. One taken from a specimen 160 mm. long contained twenty-seven entomostraca, two larvæ of insects and

[12] Kaup, Apod. Fish Brit. Mus., 1856.

one Hydrachnid. The other stomach came from a specimen 180 mm. long and held eighteen dipterous larvæ and one large Odonate larva. Both specimens were from Santarem.

(4) *Sternarchorhynchus oxyrhynchus* (Müller and Troschel).

Head produced into a long, decurved, tubular snout; mouth very small, terminal, and inferior; teeth minute in both jaws; size moderately large. The table lists the contents of the stomachs of three small specimens.

Locality.	Length.	Entomostraca.	Dipterous Larvæ.	Other Insect Larvæ.	Annelida.	Vegetable Debris.
Amatuk.....	240	.....	7	.....	9	*
Amatuk.....	180	1	10	1	6	
Amatuk.....	165	.....	4	.....	17	
Total.....		1	21	1	32	

(5) *Sternarchorhamphus mülleri* (Steindachner).

Head produced into a long, straight, tubular snout; mouth rather small and somewhat inferior; teeth minute in both jaws; size large, reaching 800 mm. in length. Two stomachs of this species were examined and the contents are stated in the following table:

Locality.	Length.	Entomostraca.	Dipterous Larvæ.	Other Insect Larvæ.	Annelida.	Vegetable Debris.
Pará.....	425	1	13	5	2	*
Pará.....	400	.....	30	.....	10	
Total.....		1	33	5	12	

The food of the last two species, *S. oxyrhynchus* and *S. mülleri*, consisted almost entirely of mud-inhabiting forms. The Annelida were small mud-worms and the dipterous larvæ were similar to the North American "Blood Worm." In addition to the food listed in the foregoing table and that given with the preceding species large amounts of mud were found in all stomachs of these species which were examined. There is thus a great similarity between the contents of the stomach of these two species and of *Rhamphichthys rostratus*. Not only were the same forms eaten by these three species, but they were evidently taken in the same manner. The anterior thirds of these three species are similar. All three have the head produced into a long tubular snout. The snout of *S. oxyrhynchus* is decurved so that the mouth is on a level with the outer edge of the anal fin. The snout of *Rhamphichthys rostratus* is straight but is joined to the rest of the head at an angle to the long axis of the body so that it is directed downward. This places the mouth on a level with the origin of the anal fin. The mouth is

inferior. The snout of *S. mülleri* is also straight and is only slightly out of line with the long axis of the body. It is, however, directed downward to some extent and the mouth is more or less inferior. All three species are thus adapted to feed upon the bottom fauna with the minimum of effort. It seems probable that they feed by sucking up quantities of mud and food after a suitable feeding-place has been found. Forms like these taken from the stomachs are usually found in large numbers, close together.

No stomachs of the long-snouted *Gymnorhamphichthys hypostomus* Ellis were examined.

General Considerations.

Two factors control the nature of the food taken by any fish, namely, (1) the structure, and (2) the size of the fish. In the *Gymnotidæ* the only structure that needs consideration is the mouth. The other structures which might influence the selection of food, such as shape, nature of fins, and the like, are all held in common by the several species of this small family. Considering size and mouth there are four types of *Gymnotidæ*, (1) large, large-mouthed specimens (adult only); (2) small, large-mouthed (young of large-mouthed); (3) large, small-mouthed eels; and (4) small, small-mouthed eels. The last three are ecologically the same, since they all have small mouths. Class two, however, differs in that the members of this group ultimately by growth attain to the first class. *G. carapo*, *E. electricus*, *S. macrurus*, *S. albifrons* and *S. brasiliensis* are the large-mouthed species of this family.

They are the only species examined which had eaten either fish or freshwater shrimps, or both. These two items, which are the most bulky food taken from Gymnotid stomachs, were found only in the largest specimens of the species belonging to the first class.

A comparison of the various tables shows that the young of all species partake of much the same food. They feed upon entomostraca, the larvæ of insects and small annelids. The second, third, and fourth classes are therefore alike as regards the food taken. There remains, however, the ability of the second class to change. Forbes has found that the food of all small North American fishes is much the same, being for the most part entomostraca and the larvæ of insects. For the predaceous fishes those which as adult feed largely upon other fishes he has also shown a regular cycle of foods from the young to the adult. Beginning with entomostraca and insect larvæ they pass to Annelida and adult insects, small Crustacea, large Crustacea, and finally to other fishes. Precisely this progression is shown in the first two tables (pp. 168 and 170). On the other hand, the non-predaceous members of this family, which are limited by small mouths, pass only from entomostraca to insect larvæ.

Schlesinger divides the species of this family into three groups. The first group contains *E. electricus* and *G. carapo*. He imagines that the food of these two species must be the same because of their general resemblance. This was

found to be correct. His second group contains all of the long-mouthed forms, *Sternarchorhynchus, Sternarchorhamphus* and *Rhamphichthys.* These he thinks must feed on insects. In this he was mistaken. The stomachs of these species which were examined contained mud-inhabiting forms. His third group includes the remaining *Gymnotidæ.* He regards the toothless forms of this group to be plankton-feeders, and cites *Sternarchogiton* and *Steatogenys* as examples. The first mentioned was not examined. Three stomachs of the latter contained the larvæ of insects and Annelida as well as entomostraca, with Annelida much preponderating. The forms with teeth he gives as feeding upon small water-insects and perhaps vegetable matter. *Sternopygus* was found to feed upon water-beetles in particular, but also upon fish and freshwater shrimps. *Eigenmannia* on the contrary took very few insects, but a great number of entomostraca and larvæ of insects.

Summary.

1. Entomostraca supplemented by the larvæ of insects form the main food of the young of all species examined.

2. Only the adult large-mouthed species fed upon freshwater shrimps and fishes.

3. The adult small-mouthed species feed upon entomostraca, insect larvæ, and adult insects.

4. The long tubular-mouthed species are bottom-feeders. Their food is mud-inhabiting forms, Annelida, and insect larvæ, sucked up with the surrounding mud.

Reproduction.

Nothing is known of the breeding habits of the *Gymnotidæ.* Several unsuccessful attempts have been made to obtain embryos or very small electric eels. This failure has tended to confirm the belief of the natives that the electric eel as well as the other *Gymnotidæ* brings forth living young. But no Gymnotids have ever been captured containing embryos, nor is the construction of the genital tracts such as would favor this view, except in one particular. In most species there is a more or less well developed papilla at the terminal opening of the sex ducts just below the head. Sachs (116 et seq., l. e.) was of the opinion that the electric eel lays eggs. He collected several females with ripe eggs in February and March. He thought the period of laying to be in the early part of the rainy season, that is, the last of December and the first of January. Miller (Bull. Am. Mus. Nat. Hist., Vol. XXIII, 1907) states that he took many females of *Gymnotus carapo* with eggs from the swamps and a sluggish stream near Los Amates, Guatemala, on Feb. 20, 1905. The largest of them was 200 mm. long. Among the specimens of *Eigenmannia virescens* and *Sternopygus macrurus* collected by Dr. C. H. Eigenmann in Georgetown are many females with eggs. Several females of *Eigenmannia* are very noticeably distended. Some of the specimens which I took from the same place on Sept. 26, 1910, contained eggs, but they did not seem as nearly ripe

as those collected by Dr. Eigenmann. In no case were the females at this time so full of eggs as to be distended.

Mutilations and Regeneration.

The specimens of *Gymnotidæ* in different collections show an unusual amount of mutilation and regeneration. This condition is undoubtedly in part due to their peculiar anatomy and shape. It may be recalled that they are all slender, elongate fishes, with the visceral anatomy occupying a relatively small portion of the fish just behind the head. The viscera, except the air-bladder, are so closely packed that the mass occupies a space a little longer than the length of the head. The compound air-bladder varies in size and shape in the several species. It lies just below the spinal column on the posterior portion of the body cavity and extends caudad to between the anterior third and the middle of the body. The position of the anus is also noteworthy. The alimentary canal after several turns bends down and runs forward along the floor of the body cavity and terminates below the head or below the base of the pectorals. Back of the body cavity the body tapers off gradually. The dorsal region bears no fins, hence the name, *Gymnotidæ*. Ventrals are also wanting. All species, however, have small fan-shaped pectorals and a very long anal fin. The anal begins in the pectoral region and extends caudad for the greater length of the fish. The number of rays in this fin varies greatly among the different species and also among individuals of the same species. In one species, at least, the number of anal rays may exceed five hundred (*Rhamphichthys rostratus*). The species of one subfamily, the *Sternarchinæ*, have a caudal fin. The tail of the other species tapers into a slender, cylindrical, caudal appendage.

Mutilation and the attendant regeneration are of general occurrence throughout this family. Many of the accounts of the *Gymnotidæ* note either in passing or even in detail, cases of regeneration in the caudal and anal regions. Nineteen of the twenty-seven species of this family are known to have regenerated lost portions. The present account consists of three parts: the first deals with regeneration in general in this group, and is based both on the collections examined and on the cases recorded by others; the second relates to special collections of three species; and the third gives an account of some experiments carried on during the Gimbel Expedition.

Part I. Regeneration in General.

The first table lists all of the species of the *Gymnotidæ* and indicates those known to have regenerated lost parts. Whenever specimens were at hand showing injury and regeneration, the word "specimens" follows, while cases not examined by myself are referred to the author mentioning them. Reference to several interesting regenerations recorded for species of which mutilated specimens were examined by myself is omitted from this table. It demonstrates the general occurrence of regeneration throughout the family, regeneration being recorded for

all but two of the sixteen genera. The eight species without recorded cases of regeneration are known by but few specimens.

Name of Species.	Caudal Fin.	Caudal Append-age.	Anal Region.	Author-ity.
1. Gymnotinæ:				
1. *Electrophorus electricus* (Linnæus)	.....	.....	*	Sachs
2. *Gymnotus carapo* (Linnæus)	.....	*	*	Spms.
2. Sternarchinæ:				
1. *Sternopygus macrurus* (Bloch & Schneider)	.....	*	*	Spms.
2. *Sternopygus obtusirostris* Steindachner	.....	*	*	Spms.
3. *Eigenmannia macrops* (Boulenger)	.....	*	*	Spms.
4. *Eigenmannia virescens* (Valenciennes)	.....	*	.....	Steind.
5. *Eigenmannia troschcli* (Kaup)	.....	*	.....	Steind.
6. *Steatogenes elegans* (Steindachner)	.....	*	*	Spms.
7. *Hypopomus brevirostris* (Steindachner)	.....	*	*	Spms.
8. *Hypopomus artedi* (Kaup)	.....	*	*	Spms.
9. *Rhamphichthys rostratus* (Linnæus)	.....	*	*	Spms.
10. *Gymnorhamphichthys hypostomus* Ellis	.....	*	*	Spms.
3. Sternopyginæ:				
1. *Sternarchorhynchus oxyrhynchus* (Müller & Troschel)	*	.....	.....	Spms.
2. *Sternarchorhamphus mülleri* (Steindachner)	*	.....	.....	Spms.
3. *Sternarchorhamphus macrostomus* (Günther)				
4. *Sternarchus albifrons* (Linnæus)	*	.....	.....	Steind.
5. *Sternarchus brasiliensis* Reinhardt				
6. *Sternarchus bonaparti* Castelnau	*	.....	.....	Spms.
7. *Sternarchus leptorhynchus* Ellis	*	.....	.....	Spms.
8. *Sternarchus hasemani* Ellis	*	.....	.....	Spms.
9. *Sternarchella schotti* (Steindachner)	*	.....	.....	Spms.
10. *Sternarchella balænops* (Cope)				
11. *Sternarchogiton nattereri* (Steindachner)				
12. *Porotergus gymnotus* Ellis	*	.....	.....	Spms.
13. *Porotergus gimbeli* Ellis				
14. *Adontosternarchus sachsi* (Peters)	*	.....	*	Spms.
15. *Orthosternarchus tamandua* (Boulenger)	*	.....	.....	Boulg.

Gymnotinæ, *Electrophorus electricus* (Linnæus). According to Sachs (*op. cit.*, 1881, p. 11), the long anal fin and confluent caudal of the electric eel were often found slightly injured and in various stages of regeneration. These injuries were usually V-shaped rents in the fins. The parts restored were fin-membranes and rays. The regenerations in some cases seemed fairly complete, none of the nine specimens in the present collections were found to be injured.

Gymnotus carapo Linnæus. This species is an almost cylindrical fish, rather pink with a greenish cast in life and crossed by blue-gray or greenish bands. The body tapers somewhat in the caudal region and ends in a small, cylindrical caudal appendage, which never exceeds the snout in length. The head is rather flat, and both of the strong jaws contain one or two rows of conical teeth. The adult of this species is largely predaceous. Only seven cases of regeneration were found among two hundred and forty individuals of *G. carapo* examined.

The collections of this species include specimens of all sizes from forty-eight localities. Four of the injured ones had lost only a few millimeters of caudal

appendage. The following table gives the data for these. All three of the localities from which they came are in British Guiana.

Gymnotus carapo.

No.	Locality.	Number of Specimens.	Length of Body.	Number Injured.
1	Holmia	34	80–435 mm.	2
2	Nickaparoo	32	80–340 mm.	1
3	Tukeit	30	51–310 mm.	1
	Total	96		4

The other three cases proved more interesting.

One specimen, body length estimated 125 mm., from the Rio Coite, Eastern Brazil, had lost the entire caudal appendage and about twenty millimeters of the caudal portion of the body. It had been lost by an irregular injury which ran at right angles to the back. The regeneration had been most rapid in the region of the backbone. The new tissue at this point being six millimeters long and bearing a new caudal appendage nearly two millimeters in length. There had been scarcely any repair to the extreme ventral edge of the injury in the region of the anal fin. The entire piece of regeneration tissue was thus roughly triangular. It bore along its ventral margin several very tiny fin-rays, not over half a millimeter long, and its maximum thickness was nearly two millimeters, only about one-half that of the uninjured body, just in front of it. The dorsal portion of the new tail was scaled over most of its basal half. The regenerated portion was uniformly pale yellow in color and without markings. Fig. 19 is an outline drawing of this tail.

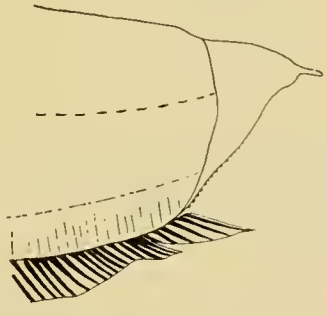


Fig. 19. Regenerated Tail. *Gymnotus carapo* (Linnæus), Rio Coite.

Another individual three hundred millimeters long, from the Amazon at Santarem, Brazil, had received nearly the same kind of injury, differing, however, in that the regeneration was much farther advanced. (See Fig. 20.) Nearly eighty millimeters of the body, and the entire caudal appendage, had been lost by a rather straight injury across the body. Of this sixty-five millimeters had been regenerated. The new tail bears a caudal appendage eight millimeters long and a small well developed fin. The latter is completely, although irregularly, joined to the unin-

jured anal. The entire piece was normally scaled and marked with the typical bands of pale yellow and dark blue (compare with Fig. 22, the normal tail). It differed chiefly in being a little smaller than the uninjured part of the body, which gave the fish a constricted appearance along the line of injury.

Fig. 20. Regenerated Tail. *Gymnotus carapo* (Linnæus), Santarem, Brazil.

The third case was quite different. This fish, a specimen one hundred and thirty millimeters long, from Aqua Quente, Paraguay, had received an injury parallel to the lateral line. The caudal appendage and caudal portion of the body were split for a distance of thirty-five millimeters. Both pieces had rounded themselves out so that there were two well-formed caudal appendages, each longer than the normal. The ventral tail has an anal fin regularly attached except for a slight fold (see Fig. 21).

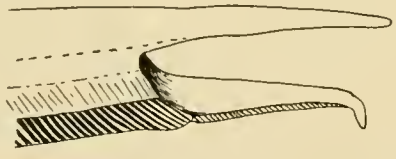


Fig. 21. Split Tail. *Gymnotus carapo* (Linnæus), Aqua Quente, Paraguay.

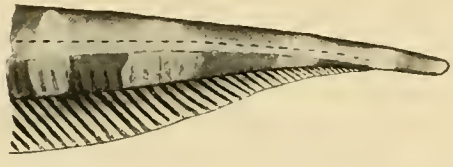


Fig. 22. Normal Tail. *Gymnotus carapo* (Linnæus), Holmia, British Guiana.

Taken collectively these regenerations show *G. carapo* capable of rather complete regeneration of injuries in the caudal region. Caudal appendage, muscle scales, color markings, and anal fin were all restored. It, of course, could not be determined absolutely whether these injuries had been received when the fishes were much smaller and the regenerated parts, after some fraction of the part removed had been restored, had grown with the rest of the fish, or whether the regenerations were the results of recent injuries, and really represent the amount of tissue lost. The appearances all favor the view that the injuries were recent. The

scars are clear and well defined, and the new tissue quite distinct from the old, conditions that would probably not obtain were the injuries old ones.

The small number of individuals of this species showing any mutilation could be explained in either of two ways. *First*, it is possible that injuries of greater severity than the slight mutilation of the caudal appendage were fatal, and consequently no specimens collected showed these; or *secondly*, the species *G. carapo* is not frequently injured. The first explanation evidently does not obtain, for, two specimens previously mentioned (see Figs. 19 and 20) had each not only lost the entire caudal appendage, but a considerable portion of the body as well, and more than merely surviving these injuries, had restored by regeneration much of the part lost. Concluding that *G. carapo* is only occasionally injured, the causes for this immunity are to be sought, and the color-pattern and the predaceous habit of the species present themselves as probable reasons for their exemption from injury.

In life this fish is strikingly marked with numerous bands of greenish blue, which cross the body at right angles. An isolated individual is thus rather conspicuous, yet these same bands may afford a certain protection when this species lurks among the vertical stems of the calladium, the "Mucka Mucka" and other aquatic plants, forming its normal habitat in the small streams which it frequents. It was observed to be a very rapid, vigorous swimmer, and the contents of the stomachs examined, as well as the shape of the head and jaws, show this fish to be predaceous, at least as an adult. Both factors probably contribute to the immunity of this species. Plate XX, fig. 4 is an outline drawing in which the seven injuries discussed in connection with this species are indicated by outlines of the injuries.

Sternopyginæ.—The species of the *Sternopygiuæ* are distinctly compressed and more or less elongate. The caudal appendage is slender and well developed, being almost a third as long as the entire body in some species. Two of the genera, *Eigenmannia* and *Sternopygus*, have patches of very small teeth in each jaw, while the others are toothless. All the species of the subfamily feed largely upon plankton, insects, and worms. One of the first records of regeneration in this subfamily is by Kaup, 1856, who prefaces his discussion of the genus *Rhamphichthys* with the following: "One perceives sometimes at the point of the damaged tail a projecting cuticular process destitute of vertebræ which resembles the reproduced tail of a lizard. Judging from the narrowness of the toothless mouth these fish must subsist on small insects and be themselves destroyed or injured by predaceous fish whence it happens that the point of the tail is often defective."

From the following table it is plain that regeneration is common among these species. The injuries were of two sorts: (1) part of the caudal appendage sometimes with more or less of the caudal region of the body had been removed; (2) V-shaped, or semicircular, pieces of the anal fin and its muscles had been taken out of the ventral region, often well cephalad. The particular cases are considered in the second part. The regeneration in many cases was quite complete, muscle, fin-rays, scales, pigment, and caudal appendage having been restored.

The general data for this subfamily are given in the table here given:

Species of Sternopyginæ.	Specimens Examined.	Specimens Injured.	Per Cent.	Number of Localities.
1. *Sternopygus macrurus*	214	20	10	27
2. *Sternopygus obtusirostris*	None			
3. *Eigenmannia macrops*	56	7	12	3
4. *Eigenmannia virescens*	482	72	15	63
5. *Eigenmannia troscheli*	3	0	0	1
6. *Steatogenes elegans*	19	2	11	3
7. *Hypopomus brevirostris*	56	4	8	19
8. *Hypopomus artedi*	90	7	8	16
9. *Rhamphichthys rostratus*	8	2	25	4
10. *Gymnorhamphichthys hypostomus*	11	1	9	7

Sternarchinæ.—The presence of a small caudal fin is the main point of difference between the *Sternarchinæ* and the other three subfamilies. The fishes of this group are quite compressed. In the cephalic and pectoral regions the body is more or less suddenly tapered into a peduncle which bears the caudal fin. All the species, with the exception of *Adontosternarchus sachsi* (Peters), have teeth. Few specimens of this subfamily, in comparison with the *Sternopyginæ*, were examined, yet the general occurrence of regeneration throughout the group is evident from the following table. The several species will be considered separately.

Species of Sternarchinæ.	Specimens Examined.	Specimens Injured.	Per Cent.	Number of Localities.
1. *Sternarchorhynchus oxyrhynchus*	9	1	10	4
2. *Sternarchorhamphus mülleri*	5	3	60	2
3. *Sternarchorhamphus macrostomus*	None			
4. *Sternarchus albifrons*	9	0	0	4
5. *Sternarchus brasiliensis*	2	0	0	1
6. *Sternarchus bonaparti*	2	1	50	2
7. *Sternarchus leptorhynchus*	3	0	0	1
8. *Sternarchus hasemani*	13	13	100	1
9. *Sternarchella schotti*	5	5	100	1
10. *Sternarchella balænops*	None			
11. *Sternarchogiton nattereri*	None			
12. *Porotergus gymnotus*	4	1	25	2
13. *Porotergus gimbeli*	4	0	0	1
14. *Adontosternarchus sachsi*	57	5	9	2
15. *Orthosternarchus tamandua*	None			

The single individuals of *Sternarchorhynchus oxyrhynchus* (Müller and Troschel), and *Porotergus gymnotus* Ellis, and the five of *Adontosternarchus sachsi* (Peters) noted in the above table as regenerating were each repairing small injuries to the anal fin, rays and fin-membrane having been lost. None of these regenerations were completed.

Two specimens of *Sternarchorhamphus mülleri* (Steindaehner), from Pará, Brazil, each about four hundred and thirty millimeters long, had lost the entire caudal peduncle and caudal fin, the line of injury running across the body through the end of the anal fin. Comparison with an uninjured specimen of the same

size showed the part removed to have been about sixty-five millimeters long and ten by six millimeters deep at its base. In repairing these injuries neither had regenerated a caudal peduncle. Instead, from the line of injury both had regenerated a broad fan-shaped fin, nine millimeters long on fish "A" (Fig. 23) and

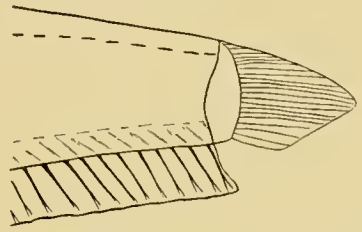


Fig. 23. Regenerated Tail of *Sternarchorhamphus mülleri* (Steindachner). Fish "A."

twelve millimeters on fish "B" (Fig. 24). Both regenerated fins had the shape of

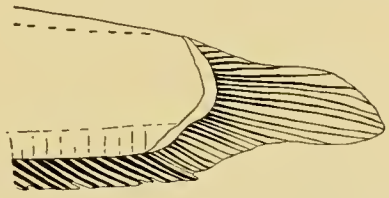


Fig. 24. Regenerated Tail of *Sternarchorhamphus mülleri* (Steindachner). Fish "B."

the normal caudal fin, from which they differed in three particulars, (1) both were much larger than the normal caudal; (2) each contained more rays than the normal caudal which has only ten rays, while the regenerated fin of specimen "A," nine millimeters long, contained twenty, and the fin of "B," twelve millimeters long, contained twenty-six rays; (3) they were situated at least fifty millimeters nearer the head than the normal fin, arising from the body directly and not from the slim caudal peduncle. The fin twelve millimeters long differed in still another respect; it was confluent ventrally with the anal fin. Figures 23 and 24 show the regenerated fins "A" and "B" respectively, and Figure 25 a normal caudal of this

Fig. 25. Normal Tail and One Fourth of Caudal Peduncle. *Sternarchorhamphus mülleri* (Steindachner).

species. The third specimen had lost only the caudal fin and the extreme tip of the caudal peduncle. From the old tissue a small bud of new tissue projected. As this was quite small and showed no structure, it is probable that this fish had been injured only a short time before it was captured.

No specimens of *Sternarchus albifrons* Linnæus, *Sternarchus leptorhynchus* Ellis, or *Porotergus gimbeli* Ellis, were found with regenerations, and, the last named two species being new, no mutilations have been noticed by others. On

the other hand Steindachner, who has examined many specimens of *Sternarchus albifrons*, observes that the caudal region of most of the individuals had been mutilated and the caudal fin regenerated. He says: "Seit der Publication meiner Abhandlung über die Gymnotidæ des K.K. Hof-Naturaliencabinetes zu Wien im Jahre 1868 habe ich mehrfach Gelegenheit gehabt Exemplare von *Sternarchus albifrons* sp. Linné zu untersuchen, darunter viele aus dem See Manacapuru, von Teffé, Obidos (im Museum zu Cambridge, Massach., Thayer-Expedition). Bei den meisten derselben war das Schwanzende verstümmelt und die caudale regenerirt." (Flussfische Süd Amer., III, 1881, p. 13.) This species which reaches the length of five hundred millimeters, or more, is entirely black save for two bright pink bands around the tail and a band of the same color along the top of the head. Is it that these strikingly colored bands attract other fish and account for the frequent injury of the caudal region?

A specimen of *Sternarchus bonaparti* Castelnau, from Santarem, Brazil, had a regenerated caudal very similar to those regenerated by the two individuals of *Sternarchorhamphus mülleri*. This fish, estimated to be about one hundred and forty millimeters long, representing an inconspicuous brown species, had lost about thirty millimeters of the caudal portion of the body, as well as the entire caudal fin. From near the backbone there had been regenerated a symmetrical, rounded caudal fin, eight and a half millimeters long, and a well-scaled, seemingly normal caudal peduncle some four millimeters in length. (This caudal peduncle is much shorter than the normal one.) In the angle between the new caudal peduncle and the old anal fin there is a small piece of regenerated anal fin bearing six new anal rays. The new caudal fin is quite normal in shape although distinctly larger than a normal caudal, and perhaps a little rounder. It contains twenty-three rays as compared with twenty in the normal caudal. (See Figure 26.)

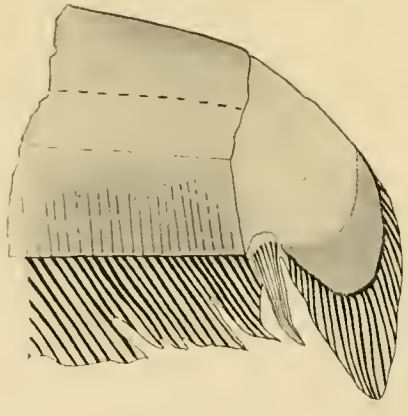


Fig. 26. Regenerated Tail. *Sternarchus bonaparti* Castelnau, Santarem, Brazil.

Of all the specimens of *Sternarchus hasemani* Ellis and *Sternarchella schotti* (Steindachner) examined, thirteen of the former and five of the latter had lost the entire caudal fin together with more or less of the caudal portion of the body.

These fishes are of a dull gray color in alcohol and of the same general shape as the other members of this subfamily. From the injured surfaces all were regenerating caudal fins after the fashion just mentioned in the case of *mülleri* and *bonaparti*. In no case was the new caudal confluent with the old anal fin, and in the more advanced regenerations there was a small caudal peduncle. Figure 27 shows a series

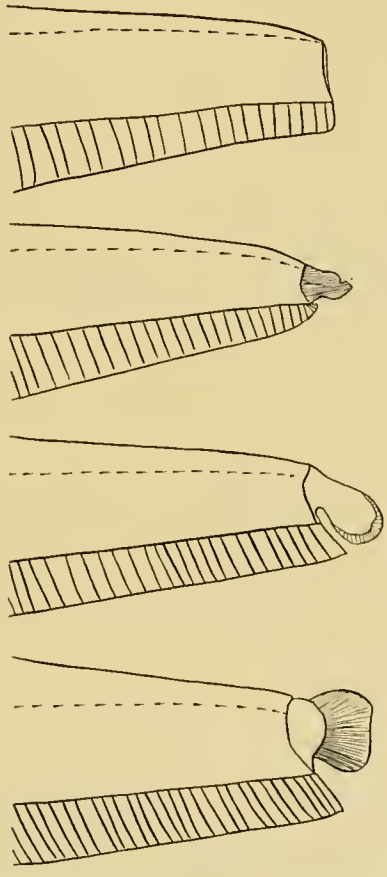


Fig. 27. Regenerated Tails of *Sternarchus hasemani* Ellis, Santarem.

of the regenerated fins of *hasemani*. Steindachner notes an interesting specimen of *Sternarchella* (*Sternarchus*) *schotti* which has regenerated a second caudal fin above the true caudal. His figure is copied in Figure 28.

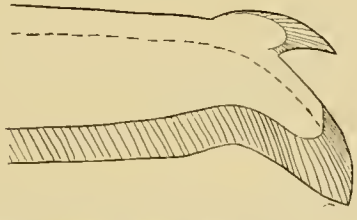


Fig. 28. Double Tail. *Sternarchella schotti* (Steind.). After Steindachner.

No specimens of *Sternarchella balœnops* (Cope), *Sternarchogiton nattereri* (Steindachner) and *Orthosternarchus tamandua* (Boulenger) were examined, and no recorded regeneration for the first two species was found. However in his original description of *O. tamandua*, Boulenger speaks of his unique type as having a regenerated caudal confluent with the anal and figures it thus (*op. cit.*, 1898, p. 427, pl. XLII). A second specimen of this same species, recorded and figured by von Ihering (*op. cit.*, 1907, p. 277, pl. VIII, fig. 1), had the same type of a regenerated caudal.

In conclusion, eight of the fifteen species of *Sternarchinæ* are known to possess the ability to regenerate muscle, fin, rays, and scales. Several of these species regenerate new caudal fins from various levels more cephalad than that at which the caudal fin normally occurs, entirely without, or with only a very small caudal peduncle. It is probable that the other species of this group would show the same type of regeneration, if enough specimens were examined, since they are so closely related to the species in which these regenerations are known to occur.

Part II. Quantitative Data.

This section deals with several large collections of each of three species; in each case all of the specimens caught at a given time and place were preserved. Most of these collections were made by Dr. C. H. Eigenmann, in British Guiana in 1908, and the others by the writer in the same country in 1910. The three species considered are *Eigenmannia virescens*, *Eigenmannia macrops* and *Sternopygus macrurus*. In life they all closely resemble each other, not only in color but in size and shape. They are quite compressed and somewhat elongate. The body

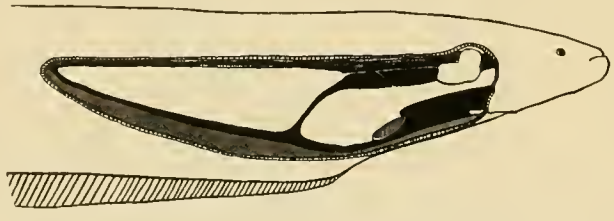


Fig. 29. Section showing location of air-bladder in *Gymnotus carapo* Linnæus.

tapers rather suddenly in the caudal region, which ends in a long, cylindrical caudal appendage, at least one-fourth as long as the entire body. The caudal appendage contains a continuation of the vertebral column, enclosed in a well-scaled sheath of skin. These fishes are so translucent that their blood gives them a distinctly red color. The epidermis is bright yellow, and beneath it are dark blue chromatophores, very abundant in *S. macrurus*, less so in *E. virescens*, and almost wanting in *E. macrops*.

In consequence of these peculiarities these species are capable of changing color to some extent. In proportion to the amount of blue pigment present they

may change through orange, purple, and green. In general they are red or orange-red, with a golden green cast dorsally. The yellow pigment dissolves in alcohol and the entire fish becomes opaque. Alcoholic specimens of *Eigenmannia* are straw-yellow, and of *Sternopygus* stone-grey (because of the greater number of blue chromatophores). Figures 29–32 give outline drawings of *G. Carapo*, *S. macrurus*, *E. virescens*, and *H. brevirostris*, showing the location of the viscera.

From these figures it may be seen that the viscera proper occupy about the same space in all of three species, but the air-bladder of *S. macrurus* is much longer, being conical in shape and extending some distance beyond the rest of the viscera.

For the interpretation of the data, the fish may be divided into three regions:

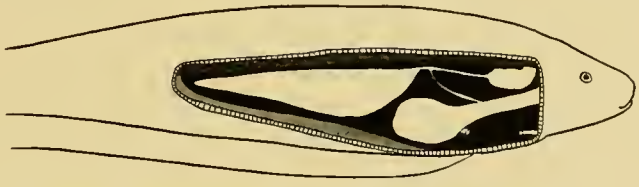


Fig. 30. Air Bladder of *Sternopygus macrurus* (Bloch and Schneider.) Side-view.

(1) all behind the middle which may be termed the "caudal half"; (2) that portion of the body in front of this line and above the lateral line which may be designated as the "dorsal quarter"; (3) that portion below the lateral line and in front of the caudal half which may be called the "ventral quarter." The detailed data of the eleven special collections of these three species is given in the following table.

Col. No.	Species.	Locality.	Length.	Number of Specimens.	Number of Regenerations.	Per Cent. of Regenerations.	Injury in		
							Caudal Half.	Dorsal Quarter.	Ventral Quarter.
1	*E. virescens*	Georgetown	105–300 mm.	155	24	15	18	0	6
2	*E. virescens*	Georgetown	100–300 mm.	50	10	20	8	0	4
3	*E. virescens*	Georgetown	160–320 mm.	35	6	17	4	0	2
4	*E. virescens*	Wismar	150–290 mm.	30	5	16	5	0	0
	Total			270	45	17	35	0	12
1	*E. macrops*	Rockstone	165–200 mm.	32	4	12	4	0	0
2		Tumatumari	165–180 mm.	12	2	17	1	0	1
3		Crab Falls	125–150 mm.	12	1	8	1	0	0
	Total			56	7	12	6	0	1
1	*S. macrurus*	Georgetown	155–500 mm.	104	8	8	6	0	2
2	*S. macrurus*	Georgetown	200–400 mm.	18	3	17	3	0	1
3	*S. macrurus*	Wismar	118–212 mm.	10	2	20	2	0	0
4	*S. macrurus*	Hububa Creek	190–300 mm.	17	3	17	3	0	2
	Total			149	16	10	14	0	5

The number of individuals found regenerating injuries of some sort is sufficient

to show that these species are subject to frequent injury. The percentage of regenerating specimens may be a little high, as it is possible that the injured ones were more easily captured, and consequently occur in the collections in greater numbers than they do among equal numbers of the same species in a normal environment. Against this, it may be said, however, that in one locality, that in which collections No. 1 of *E. virescens* and No. 1 of *S. macrurus* were made, an entire trench was drained, and all of the fishes, both normal and injured, were secured. In making the other collections, it was also the object to take the entire fish-fauna at the point selected. Granting, however, that the percentages themselves are higher than normal, they nevertheless indicate that a very appreciable percentage of all the individuals are injured. This conclusion is substantiated by a review of the general data in the table on page 000, in which the percentages of mutilated individuals of these three species are 10, 12, and 15 respectively.

The location and severity of all of these injuries are shown in Plate XX, figs. 1–4. These figures, as previously mentioned, are outline drawings of an average sized fish of each species, on which the line of each of the several injuries found in the collections of the particular species is indicated.

If the line of injury crosses the body of the fish, the loss of the entire portion of the body behind the line is indicated. It is to be understood that these plates do not represent any one fish, but the entire series of injuries found among the specimens of a single species superimposed and drawn to scale on the outline of one fish.

Considered in connection with the foregoing table Plate XX, figs. 1–4, shows one region, the dorsal quarter, to be uninjured. The majority of the injuries are in the caudal half, only about one-third of them occuring in the ventral quarter. The absence of any injury to the dorsal quarter is striking, and is made still more so by the following table, which locates all the injuries of all the specimens of these three species examined:

Species.	Regenerating Specimens.	Dorsal Quarter.	Ventral Quarter.	Caudal Half.
E. virescens	72	0	20	52
E. macrops	7	0	1	6
S. macrurus	20	0	5	15
Total	99	0	26	73

The ventral quarter and the caudal half share all of the injuries in a ratio of about 1 to 3. From a consideration of the gross anatomy and some experiments and observations made upon living specimens of these fishes in British Guiana, it was concluded that this distribution of injuries is the result of the joint action of two factors: (1) the liability of the several regions to injury; (2) the relative mortality resulting from injuries to the various parts of the body.

The habits of these species explain the first factor. The several regions of

the body are not equally exposed to injury. These fishes frequent the weeds of the trenches and small streams, for the most part feeding upon insects and small

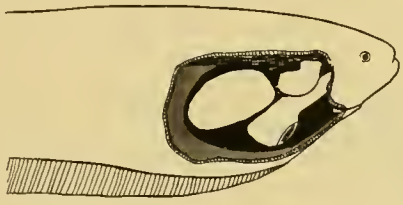


FIG. 31. Air-Bladders of *Eigenmannia virescens* (Val.). Side-view.

crustacea. They are easily frightened, and, being very swift swimmers, seek safety in flight. This habit naturally exposes the caudal region more than any other to the attack of the pursuing enemy. Because of the tapering shape and the straight dorsal profile, the sloping ventral quarter is also more or less exposed to attack from the rear.

FIG. 32. Air Bladders of *Hypopomus brevirostris* (Steindachner).

That injury to some regions of the fish would be more apt to be fatal is easily seen from the anatomy of these fishes. The anterior third of the body of the two species of *Eigenmannia* contains all of the viscera, in addition to the most important parts of the circulatory and nervous systems. *S. macrurus* does not differ materially from the two species just described, except in the size and shape of the air-bladder, previously mentioned. Its posterior air-bladder is conical and terminates about the length of the head caudad of the viscera proper. It is interesting to note in this connection that no individuals of *Sternopygus* showed injuries extending entirely across the body as far cephalad as several of those which *E. virescens* was regenerating. (See figures 30 and 32.)

With the distribution of injuries just discussed in mind, a number of experiments were made in order to ascertain the effect of various injuries and their relative severity.

PART III. EXPERIMENTS.

Forty-three specimens of *S. macrurus*, having an average length of two hundred and fifty millimeters, were collected from a large trench near the Botanic Garden, Georgetown, at about 8 A. M., Sept. 27, 1910. As these fishes were seined, they were put into buckets of the trench-water from which they had been taken and were operated upon within ten or fifteen minutes afterwards. All injuries were made with a razor, and the fishes, immediately after being operated upon, were

placed in a screened portion of a second smaller trench. As this was fed from the main trench, the fishes were returned to a normal environment. As the screened trench was only about eighteen inches wide and two feet deep their actions were

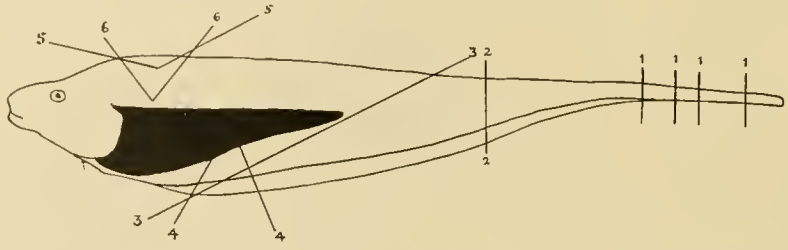


Fig. 33. Injuries used in experiment. *Sternopygus macrurus* (Bloch and Schneider).

easily observed. Figure 34 shows the several injuries discussed under these experiments. Each bears the number of the series.

Series 1. Injury to the Caudal Appendage.

Various amounts of the caudal appendage were removed from five fishes and the entire caudal appendage from three others. These, when returned to the water, swam about much the same as uninjured specimens. The loss of the caudal appendage seemed in no way to disturb their activity. When the appendage was cut off only a tiny drop of blood came to the surface of the wound. All were alive and active when observed twenty-four hours later.

Series 2. Injury to Caudal Appendage and Caudal Region.

Five more specimens were injured by the removal of the entire caudal appendage and from ten to twenty millimeters of the caudal region of the body. These, when placed in the water again, behaved much as normal fishes though they seemed less inclined to swim about at first. The removal of a larger portion of the caudal region was followed by the loss of a little blood, that is, the entire surface of the wound was covered with blood immediately after the cut was made. This blood came almost entirely from the caudal artery and spread out over the cut surface, but the bleeding stopped when the specimen was placed in water. All of these fishes were alive and active the next morning.

Series 3. Diagonal Injuries.

Five other individuals were injured by a diagonal cut which removed all of the caudal region, just missing both the viscera and air-bladder. These did not swim when returned to the water, but sank to the bottom, maintaining, however, the normal swimming position. When disturbed they swam feebly with the pectorals and the remaining portion of the anal fin, the major part of which had been removed by this injury. It is well at this point to recall that the *Gymnotidæ*

swim almost entirely with the long anal fin, the pectorals being used largely to guide the fish. All of this series were dead when visited the following morning.

Series 4. Injury in Ventral Quarter.

From the anal fin and anal muscles of ten specimens V-shaped pieces about 20 mm. wide at the base were cut, so that the point of the "V" pierced the body cavity for some five millimeters. These when dropped into the water made some rather feeble efforts to right themselves.

Seven of them died during the two hours they were observed and the other three were found dead the next morning.

Series 5. Surface Injury, Dorsal Quarter.

Wedge-shaped pieces about 20 mm. long and 5 mm. deep were cut from the middle of the back in the region above the pectorals from five specimens. The tissue thus removed included only skin, scales and dorsal muscle. These injuries bled considerably more than those of Series 2, the entire surface of the wound being covered with blood shortly after the cut was made, and blood continued to ooze from the wounds for about five minutes after each fish was returned to the water. These injuries were apparently of little consequence to the fishes, for they swam about as actively and in the same fashion as their uninjured associates. On the following morning all were found alive and active. In each case the wound had begun to heal.

Series 6. Deep Injury, Dorsal Quarter.

From the same region as that operated upon in Series 5, wedge-shaped pieces about twenty millimeters long, and deep enough to remove a portion of the vertebral column, were cut from each of ten fishes. These injuries were such as to sever the vertebral column, the spinal cord and the dorsal blood vessel, the wound thus produced bleeding considerably. The injured fish when returned to the water made disconcerted efforts to swim but soon settled to the bottom. Here they maintained a half normal position or lay completely on one side. Blood continued to ooze from their wounds for about half an hour after the operation and when they were left at the end of an hour and a half most of them seemed almost dead. None of this series were alive next morning.

In the above experiments the injuries which produced death during the first twenty-four hours after the operation were those inflicted in Series 3 (the removal of all of the body caudad of the viscera and air-bladder), Series 4 (the opening of the body cavity and air-bladder), and Series 6 (the severing of the dorsal artery, the spinal cord and the vertebral column in the suprapectoral region). Naturally, specimens regenerating such injuries were not found among the collections.

The injuries of the other three series, Series 1 (loss of the entire caudal appendage), Series 2 (removal of the entire caudal appendage plus a small portion of

the caudal region of the body), and Series 5 (surface injury to the dorsal region), did not prove fatal during the first twenty-four hours. On the contrary, the fishes of these series either were not visibly inconvenienced by the injuries, or, as far as could be observed, were completely recovered from the shock of the operation by the end of the first day. Comparing these series with the collections: the majority of mutilated specimens regenerating injuries were of the type of Series 1 or 2. Not a single individual showing an injury similar to that inflicted in Series 5 was taken. The absence of specimens with an injury of the same type as that inflicted in Series 5, namely, a non-fatal injury in the dorsal quarter, as has already been discussed, may be due to the fact that the dorsal quarter is less liable to injury than the caudal half.

Nature of Regenerations.—Regenerations were found of various degrees of completeness, in some case almost the entire part removed appeared to have been restored. Caudal appendage, anal fin, muscle tissue, skin, and scales were all regenerated. Three cases, one for each species, will suffice to show the nature of these regenerations.

A specimen of *Eigenmannia macrops* from Rockstone, estimated length one hundred and sixty-five millimeters by comparison with uninjured specimens of the same species, had lost the entire caudal appendage, about sixty-five millimeters in length, and some thirty-five millimeters of the caudal portion of the body. The regenerated piece was eighty millimeters in length, fifty millimeters being caudal appendage, and thirty millimeters body proper. The ventral edge of the thirty millimeters of body-tissue bore a well formed anal fin of normal width. It was perfectly fused with the old anal at the line of injury. The regenerated tail was much narrower both dorso-ventrally and laterally, giving the fish a pinched or constricted appearance at the line of injury. Plate XXI, fig. 1, shows a normal uninjured specimen of this species, and Fig. 2 of the same Plate represents the specimen described in the preceding lines.

A specimen of *Eigenmannia virescens* of one hundred and eighty-five millimeters in length, from Wismar, is chosen to illustrate this species. In this specimen the regeneration is especially complete. The regenerated part is quite normal in size, length, color, and markings. It differs from the uninjured portion of the fish in but two particulars: (1) it was a little thinner; (2) it did not fit quite perfectly on the ventral edge where it joined the old anal fin. The part regenerated was sixty-eight millimeters long, of which thirty-eight millimeters was caudal appendage and thirty millimeters body proper. This seemed by comparison with other normal specimens to be about the amount that had been removed. The breadth at the base was two and one-half millimeters, as compared with the three and one-half millimeters of uninjured tissue in a normal specimen, and the depth six millimeters; that of the old tissue being eight millimeters. (See Plate XXI, fig. 3.)

One of the largest specimens of *Sternopygus macrurus*, from Georgetown Trenches, five hundred millimeters long, showed three distinct injuries: (1) on the

end of the caudal appendage thirty-seven millimeters had been completely restored as far as could be determined; (2) an irregular, semicircular piece fifty-seven millimeters long and twenty-two millimeters deep had been removed from the anal fin and anal muscles quite well caudad on the anal fin. Here a strip twelve millimeters wide, bearing a narrow fringe of fin fused at both ends with the old anal, had been regenerated; (3) a piece twenty millimeters long and thirty millimeters deep was gone from the anal region about one hundred millimeters back of the head. In its place was a regenerated mass twenty-two millimeters wide with a rather complete fin on its ventral edge, this fin being fused with the old anal on both ends. This fish showed no abnormalities to account for being thus mutilated. It answered in every particular the specific measurements of the species. Plate XXI, fig. 4 gives an outline drawing of this fish showing the regenerations first mentioned.

Source of Injury.—The source of these injuries was supposed to be predaceous fishes. As many small alligators and snakes are found in the same habitat these may be responsible for part of them. The wounding of one Gymnotid was observed. A specimen of the "hoorce," *Hoplias malabaricus*, was seen to bite off the caudal portion of an *Eigenmannia virescens*. It had been placed in a small trench with several of the latter. The hoorees are abundant in all of the streams from which either *Eigenmannia* or *Sternopygus* were collected in British Guiana.

General Discussion.

The power of regeneration in the *Gymnotidæ*, as long as the injury is not fatal, is quite general. All of the species of which more than a very few specimens were examined showed some regenerated parts. As long as the mutilated specimens amount to no large fraction of the whole number, they may be considered as chance injuries. Out of a large number of individuals of any species of animal some may be expected to have been injured in the natural course of events On the other hand, when the number of injured in the collection of a given species amounts to a considerable per cent, some other factor than chance alone has probably been operative. Tabulating the total number examined in each subfamily with the number injured, we have:

Subfamily.	Number of Species.	Specimens Examined.	Specimens Injured.	Per Cent. Injured.
1. *Gymnotinæ*.....	2	250	7	3
2. *Sternopygināe*.....	10	939	115	12
3. *Sternarchinæ*.....	15	113	29	26
Total.....	27	1302	151	

This table and all of the special data show the members of the first subfamily to be subject to only chance injury, and those of the other two, to frequent injury. The immunity from frequent injury of *E. electricus*, one of the species of the first subfamily, is undoubtedly due to its remarkable electric power. The immunity

of *G. carapo*, the second species of the *Gymnotinæ*, as has already been intimated, may be the result of its color-markings and active, predaceous life. The other two subfamilies, the *Sternopyginæ* and *Sternarchinæ*, show a relatively high percentage of injured individuals. This seems to be due to two causes: (1) the exposure of a large amount of tail to injury; (2) the survival of the injuries received in the region of the tail.

The longer the caudal portion exposed the greater the chance of its being attacked and injured by other fishes. Size in itself, other things being equal, may be quite a factor in determining the liability to injury. This statement is borne out by an analysis of the injured specimens of *Sternopygus macrurus*. A larger percentage of the large fishes have been injured than of the small ones.

Sternopygus macrurus (Bloch and Schneider).

Size.	Number of Specimens.	Number Injured.	Per Cent. Uninjured.
155–250 mm.	50	7	14
250–350 mm.	100	24	24
350–500 mm.	5	3	60
Total.....	155	34	

All the specimens mentioned in this table were taken at the same time in one catch from the Botanic Garden, Georgetown. Of course the element of time in addition to that of size enters into the comparisons in this table. The larger examples, being the older, have been exposed to injury for a longer period than the smaller.

The long caudal portion, which contains no viscera or vital organs, may be mutilated without killing the fish. Specimens having been mutilated in this region are therefore in evidence. Species of a shorter type with the viscera occupying relatively much more of the body, if injured, would be more liable to be fatally affected, consequently fewer mutilated specimens would be found in a large collection. The presence of so many mutilated specimens among the collections of *Gymnotidæ* does not necessarily mean that the *Gymnotidæ* are more frequently injured than other species of the same habit subjected to the same conditions, but it does show the injuries to be less frequently fatal. The frequent injury to the caudal portion seems due to the elongated tail. Since the *Gymnotidæ* survive these injuries because of the elongate tail and the extreme cephalad position of the viscera the question arises whether they are not "protectively shaped."

Regeneration is probably of little importance to the first two species, *E. electricus* and *G. carapo*, as compared with its value to the *Sternopyginæ* and *Sternarchinæ*, for in these two subfamilies it tends to restore the protective shape. The power of regeneration seems about equally developed in both species subject to frequent injury and those not often injured. The same parts are regenerated by both groups and with about an equal degree of completeness.

Summary.

1. The power to regenerate lost portions of the caudal half and the anal region is quite general throughout the family *Gymnotidæ*. Nineteen of the twenty-seven species are known to possess this power of regeneration.

2. The part regenerated is quite like the part lost, scales, fin, fin-rays, muscles, and pigment being restored.

3. Two species at least, *G. carapo* and *E. virescens*, regenerate the parts removed very completely.

4. Several species of the *Sternarchinæ* regenerate a complete caudal fin, which may be larger and may contain more rays than the normal caudal, at whatever point the part has been removed. The caudal fin is regenerated without the restoration of more than a small portion, if any, of the caudal pedunele.

5. Experiments show injury to the caudal half to be of little consequence.

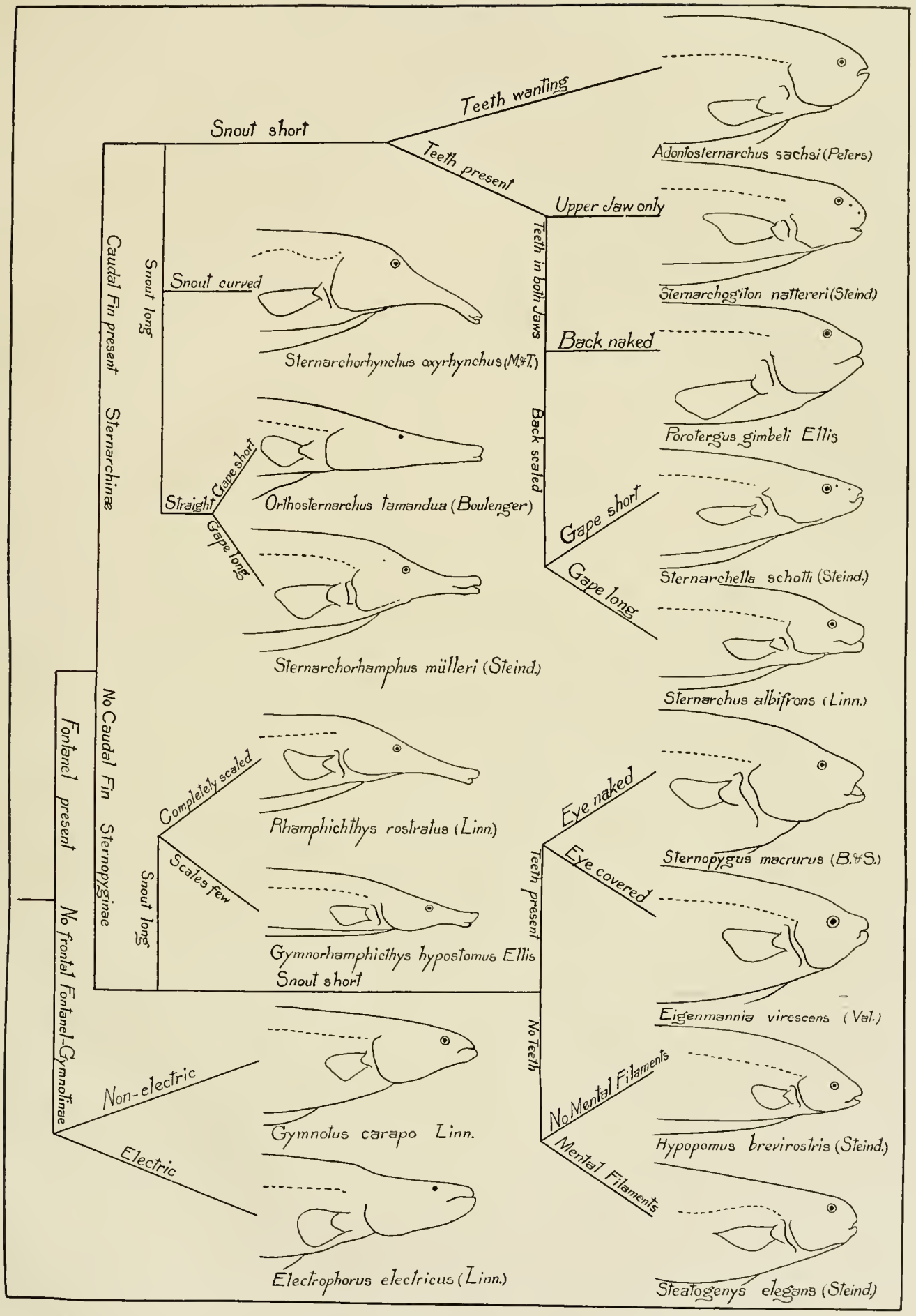
6. The majority of the injuries found were in the caudal region. This localization of injury was noted particularly in the *Sternopyginæ*, in which the caudal region bore about three-fourths of the injuries.

7. The elongated tail and the extreme cephalad position of the viscera seem to be protective adaptations.

NOTE BY C. H. EIGENMANN.

In a paper which appeared after the present contribution was offered for publication, Regan (The Classification of the Teleostean Fishes of the Order Ostariophysi.-Cyprinoidea. Ann & Mag. Nat. Hist. (8), Vol. VIII, July, 1911, pp. 13–32) recognizes four families and two subfamilies of the "Gymnotiformes" as follows:

1. Rhamphichthyidæ (*Rhamphichthys*).
2. Sternarchidæ.
   Sternarchinæ (*Sternarchus, Sternarchogiton, Sternarchorhamphus, Sternarchorhynchus*).
   Sternopyginæ (*Sternopygus, Steatogenys, Eigenmannia, Hypopomus*).
3. Gymnotidæ (*Gymnotus*).
4. Electrophoridæ (*Electrophorus*).

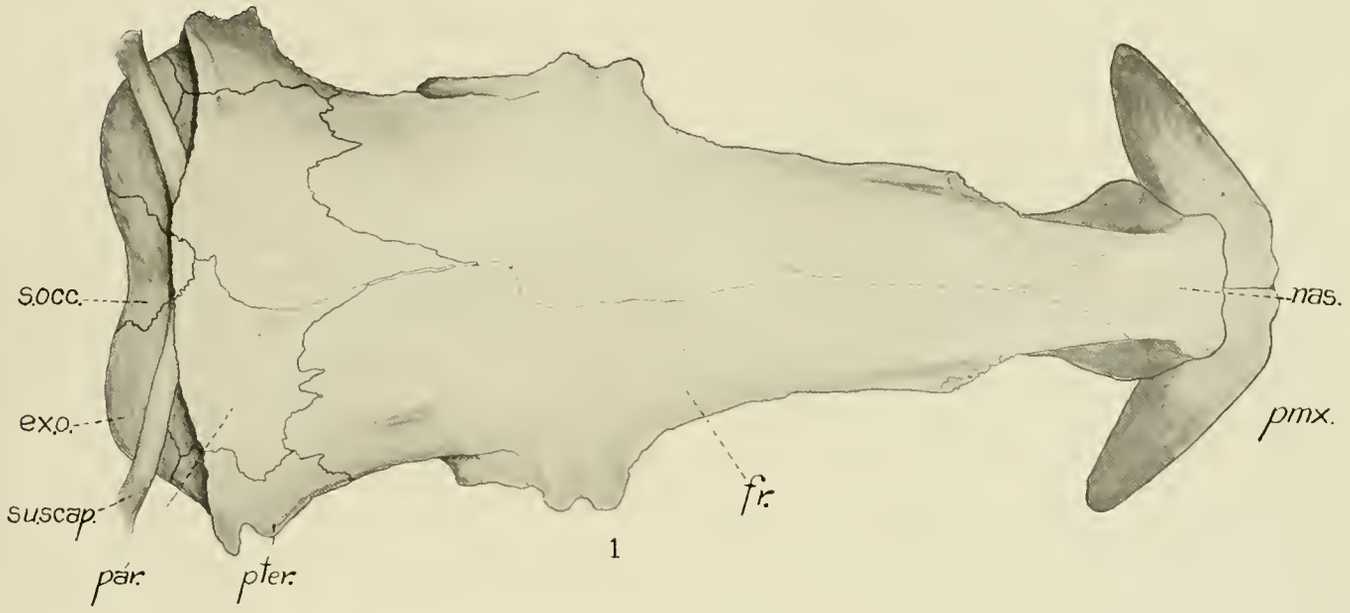


GYMNOTID EELS OF SOUTH AMERICA. GENERIC RELATIONSHIPS, PARALLELISMS, AND CONVERGENCES.

EXPLANATION OF PLATE XVI.

Skull of Gymnotus carapo Linnæus.

Fig. 1, dorsal view; Fig. 2, lateral view. *ang.*, angulare; *art.*, articulare; *b. occ.*, basi-occipital; *den.*, dentary; *ex. o.*, exoccipital; *fr.*, frontal; *h. mn.*, hyomandibular; *in. op.*, interoperculum; *msth.*, mesethmoid; *mx.*, maxillary; *nas.*, nasal; *op.*, operculum; *or. sph.*, orbitosphenoid; *par.*, parietal; *p. mx.*, premaxillary; *pr. op.*, preoperculum; *p. sph.*, parasphenoid; *pter.*, pterotic; *ptg.*, pterygoid; *qu.*, quadrate; *s. occ.*, supra-occipital; *s. op.*, suboperculum; *sph.*, sphenotic; *su. scap.*, suprascapular; *sym.*, symplectic.



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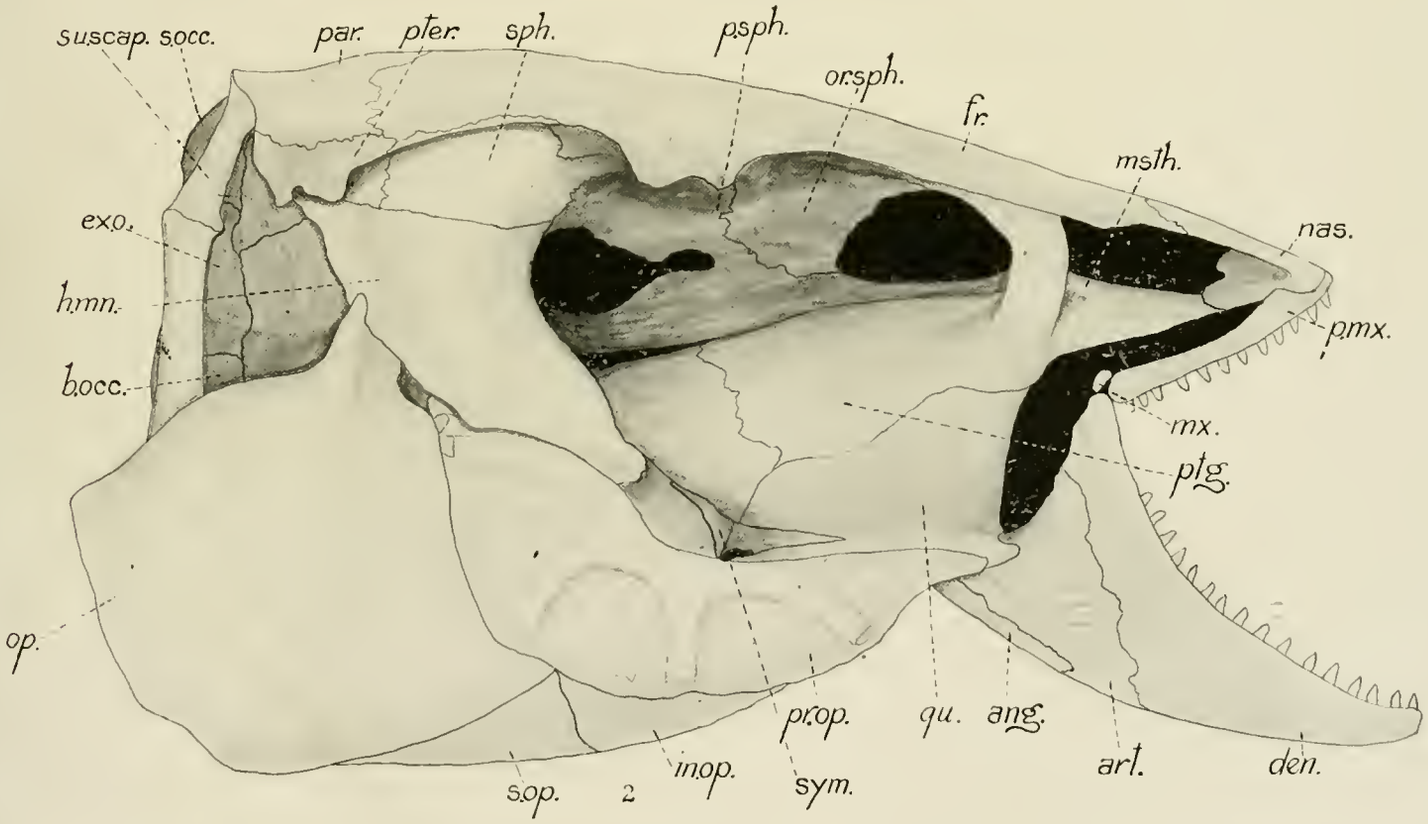

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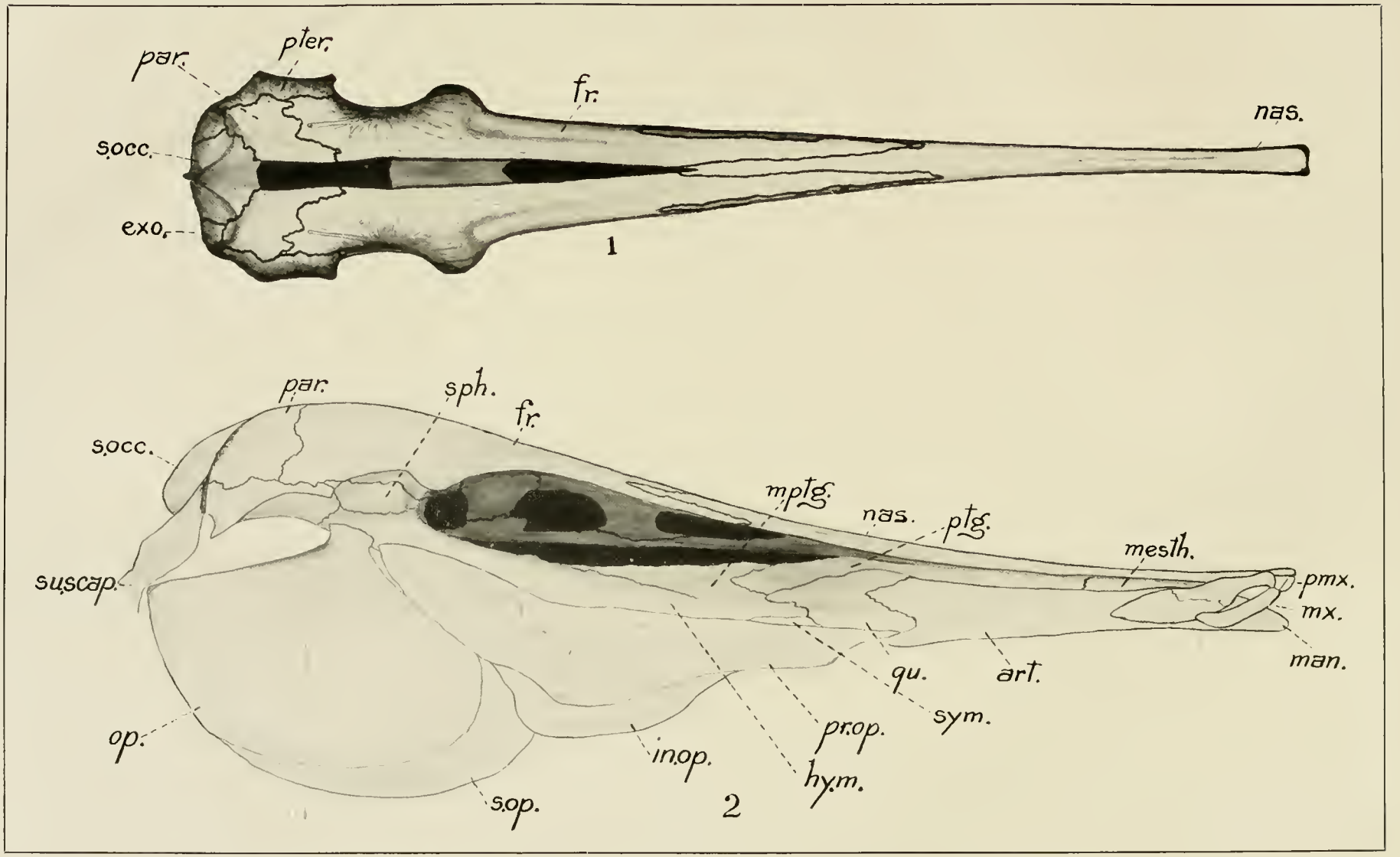
SKULL OF *Gymnotus carapo* LINNÆUS. FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XVII.

Skull of Rhamphichthys rostratus (Linnæus).

Fig. 1, dorsal view; Fig. 2, lateral view. *art.*, articulare; *exo.*, exoccipital; *fr.*, frontal; *hy. m.*, hyomandibular; *in. op.*, interoperculum; *man.*, mandible; *mesth.*, mesethmoid; *mptg.*, metapterygoid; *mx.*, maxillary; *nas.*, nasal; *op.*, operculum; *par.*, parietal; *p. mx.*, premaxillary; *pr. op.*, preoperculum; *pter.*, pterotic; *ptg.*, pterygoid; *qu.*, quadrate; *s. occ.*, supraoccipital; *s. op.*, suboperculum; *sph.*, sphenotic; *su. scap.*, suprascapular; *sym.*, symplectic.

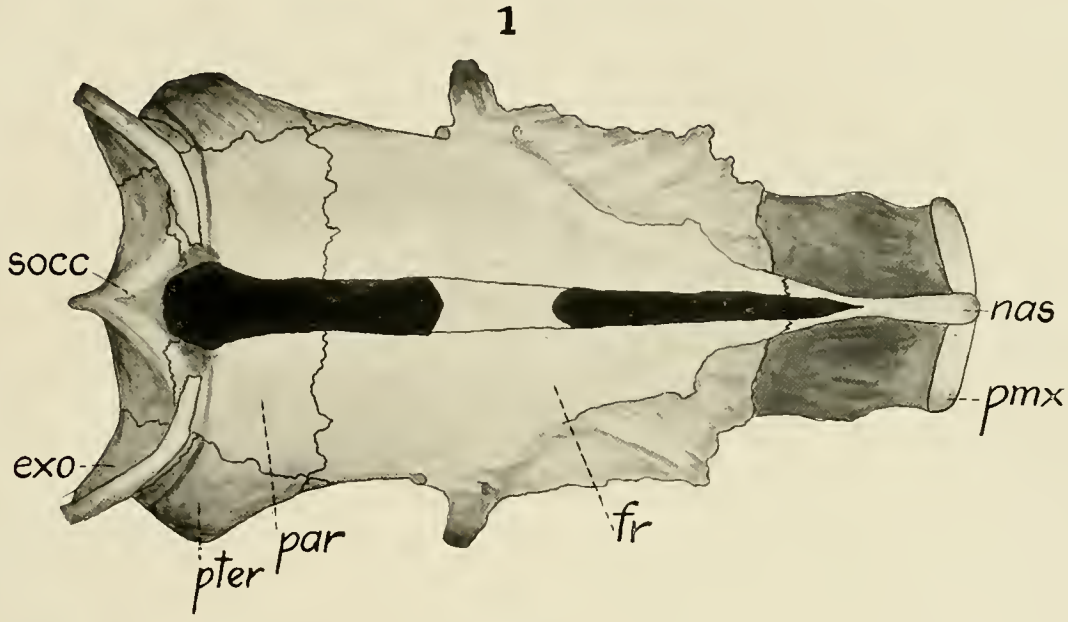


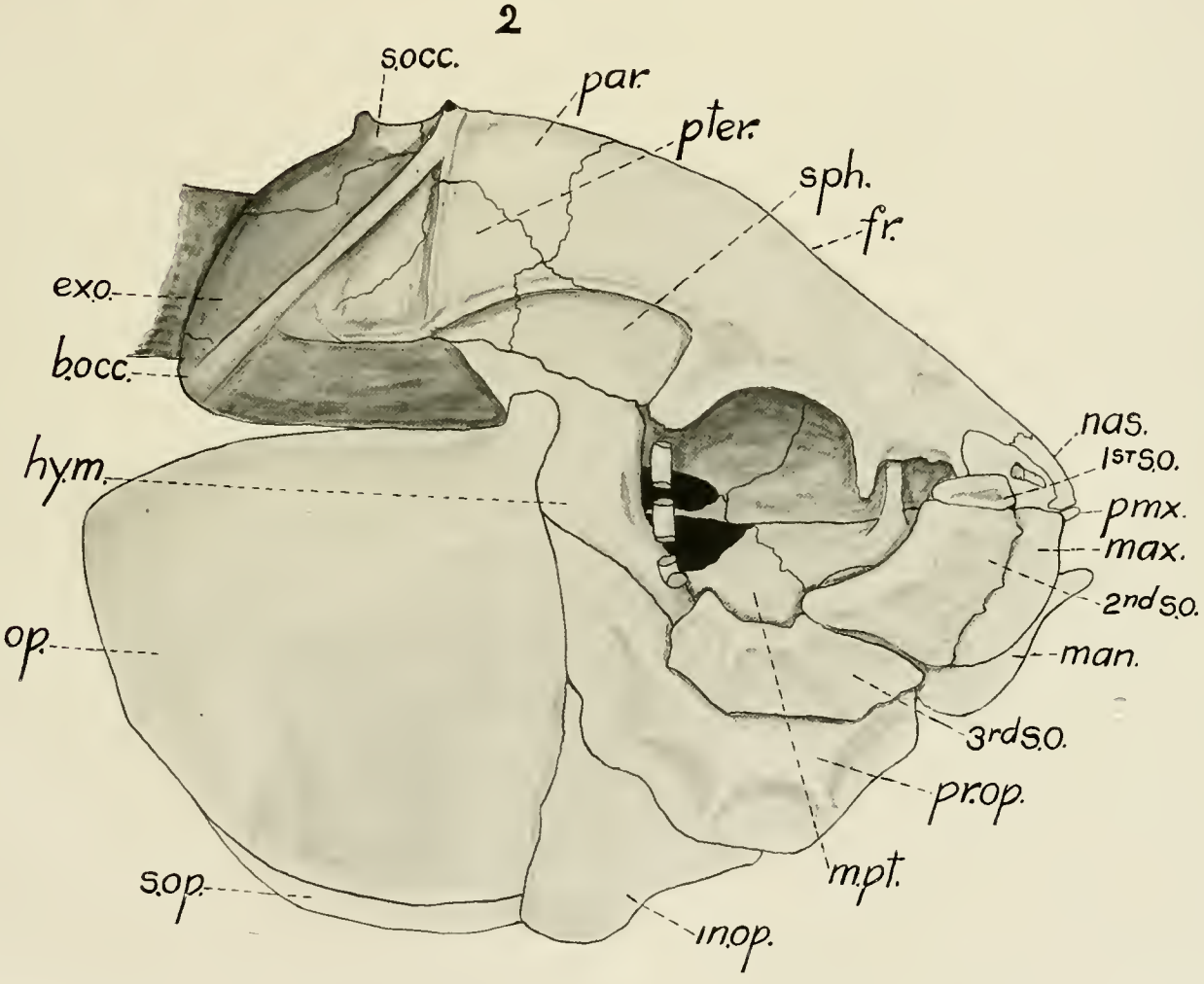
SKULL OF *Rhamphichthys rostratus* (LINNÆUS). FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XVIII.

Skull of Eigenmannia virescens (Valenciennes).

Fig. 1, dorsal view; Fig. 2, lateral view. *par.*, parietal; *pter.*, pterotic; *fr.*, frontal; *nas.*, nasal; *pmx.*, premaxillary; *exo.*, exoccipital; *spc.*, sphenotic; *b. occ.*, basioccipital; *1st. s. o.*, first suborbital; *2d s. o.*, second suborbital; *3rd s. o.*, third suborbital; *max.*, maxillary; *man.*, mandible; *pr. op.*, preoperculum; *in. op.*, interoperculum; *s. op.*, suboperculum; *op.*, operculum; *m. pt.*, metapterygoid; *hy. m.*, hyomandibular.





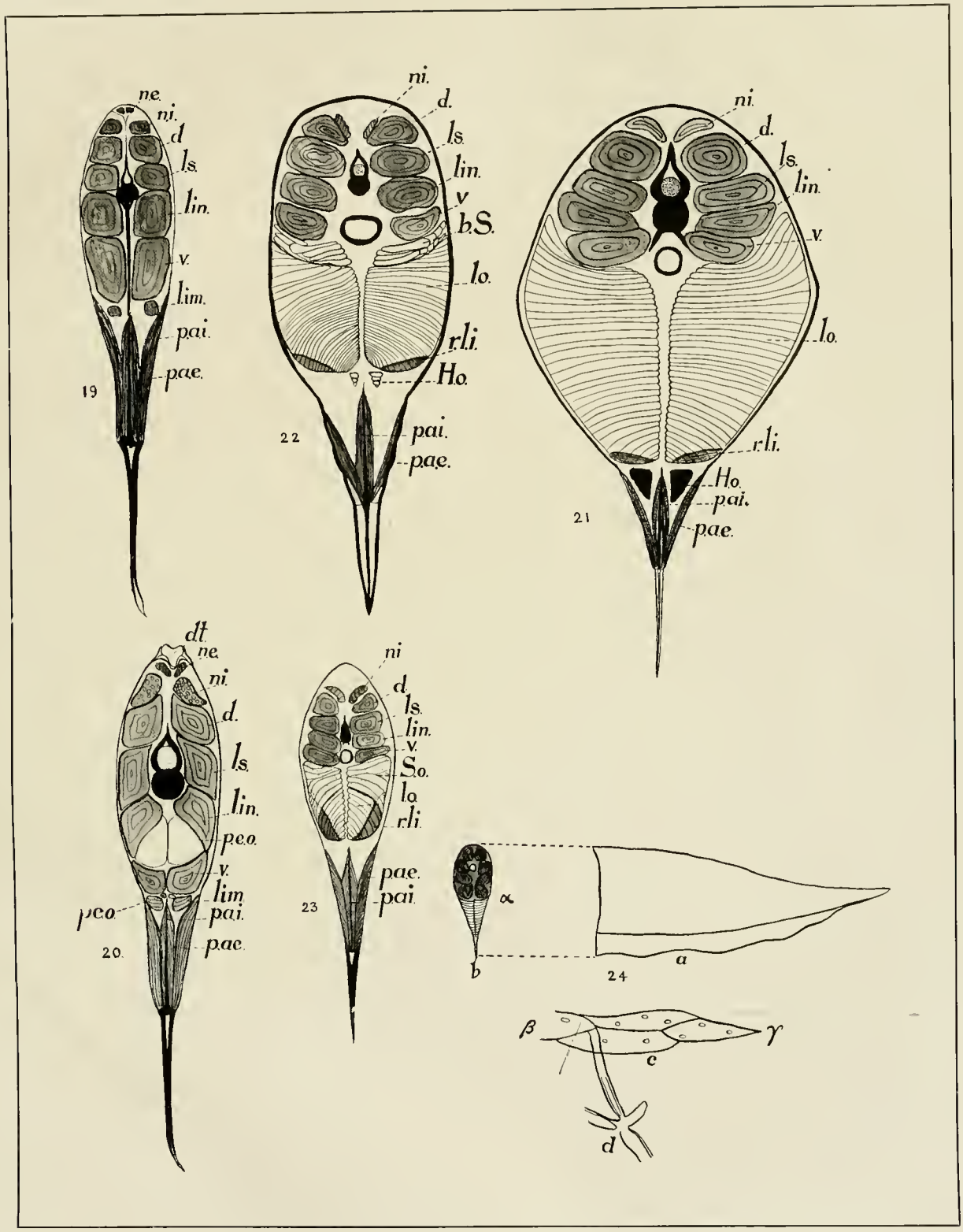
SKULL OF *Eigenmannia virescens* (VAL.). FIG. 1. DORSAL VIEW. FIG. 2. LATERAL VIEW.

EXPLANATION OF PLATE XIX.

FIG. 19. Cross-section of *Eigenmannia virescens* (Valenciennes).
FIG. 20. Cross-section of *Sternarchus albifrons* (Linnæus).
FIG. 21. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 22. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 22. Cross-section of *Electrophorus electricus* (Linnæus).
FIG. 23. Cross-section of *Electrophorus electricus* (Linnæus) near end.
FIG. 24. Pseudo-electric tissue of *Eigenmannia virescens* (Valenciennes) after Sachs. *a.* end of tail; *b.* cross-section through same; h. point corresponding to that occupied by the electric organ of *Electrophorus electricus* (Linnæus); gy. axis of distribution of structural units, which are indicated by *c.*; *d.* nerve-fibers; (after Sachs "Untersuchungen am Zitteraal" p. 69).

NOTATION OF FIGS. 19–23.

b. S., bundles of Sachs: *d.*, dorsalis; *d. t.*, dorsal thong; *H. o.*, Hunter's organ; *l. in.*, lateralis inferior; *l. im.*, lateralis imus; *l. o.*, large electric organ; *l. s.*, lateralis superior; *n. e.*, notalis externalis; *n. i.*, notalis internalis; *p. e. a.*, pinnalis analis externalis; *p. a. i.*, pinnalis analis internalis; *p. e. o.*, pseudo-electric organ; *r. l. i.*, remnant of lateralis imus; *S. o.*, organ of Sachs; *v.*, ventralis.



ANATOMICAL DETAILS OF STRUCTURE OF GYMNOTIDS.

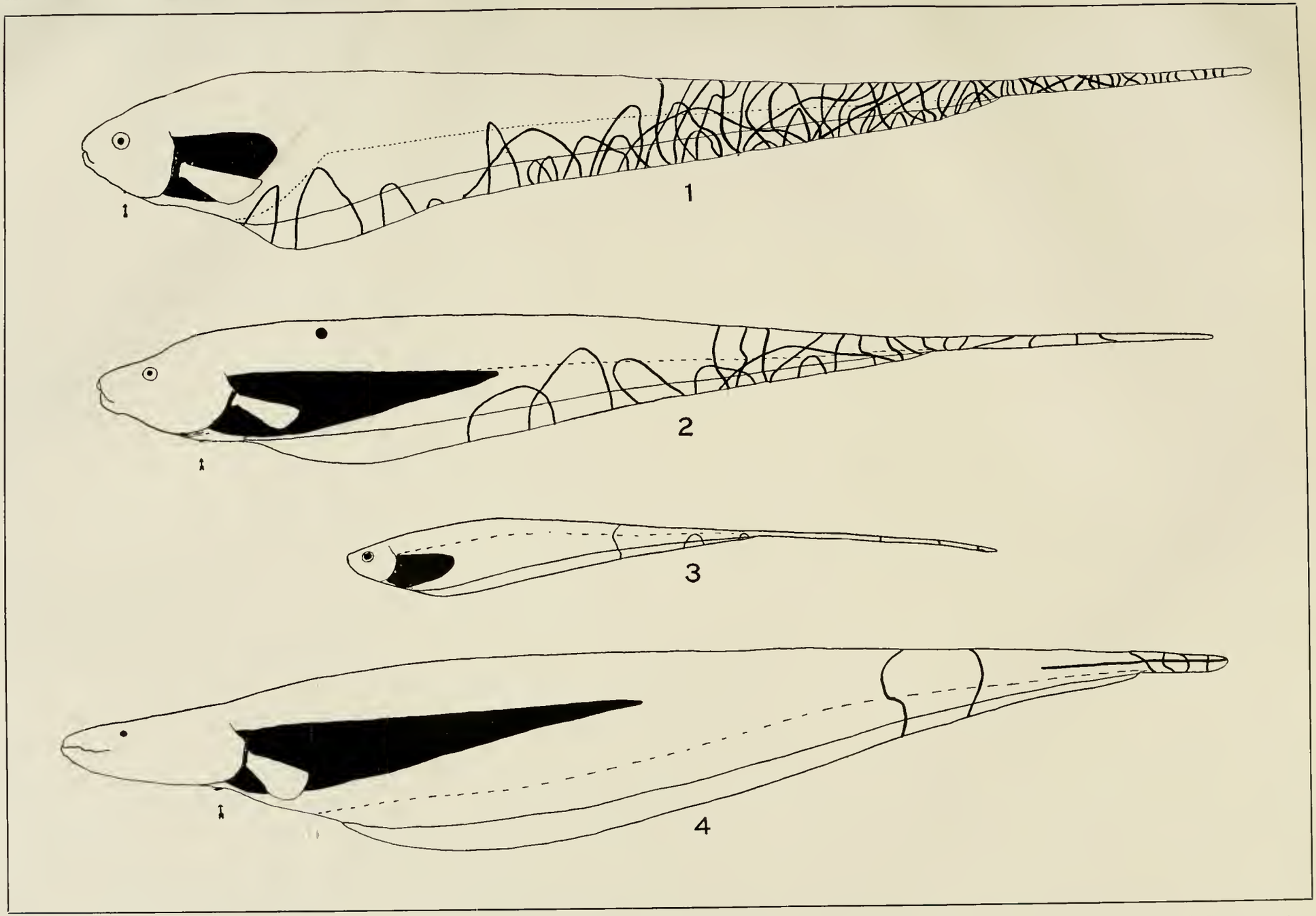


FIG. 1. OUTLINE OF *Eigenmannia virescens* (VAL.) SHOWING ALL INJURIES FOUND. FIG. 2. OUTLINE OF *Sternopygus macrurus* (BL. & SCHNEID.) SHOWING ALL INJURIES FOUND. FIG. 3. OUTLINE OF *Eigenmannia macrops* (BLGR.) SHOWING ALL INJURIES FOUND. FIG. 4. OUTLINE OF *Gymnotus carapo* (LINN.) SHOWING ALL INJURIES FOUND.

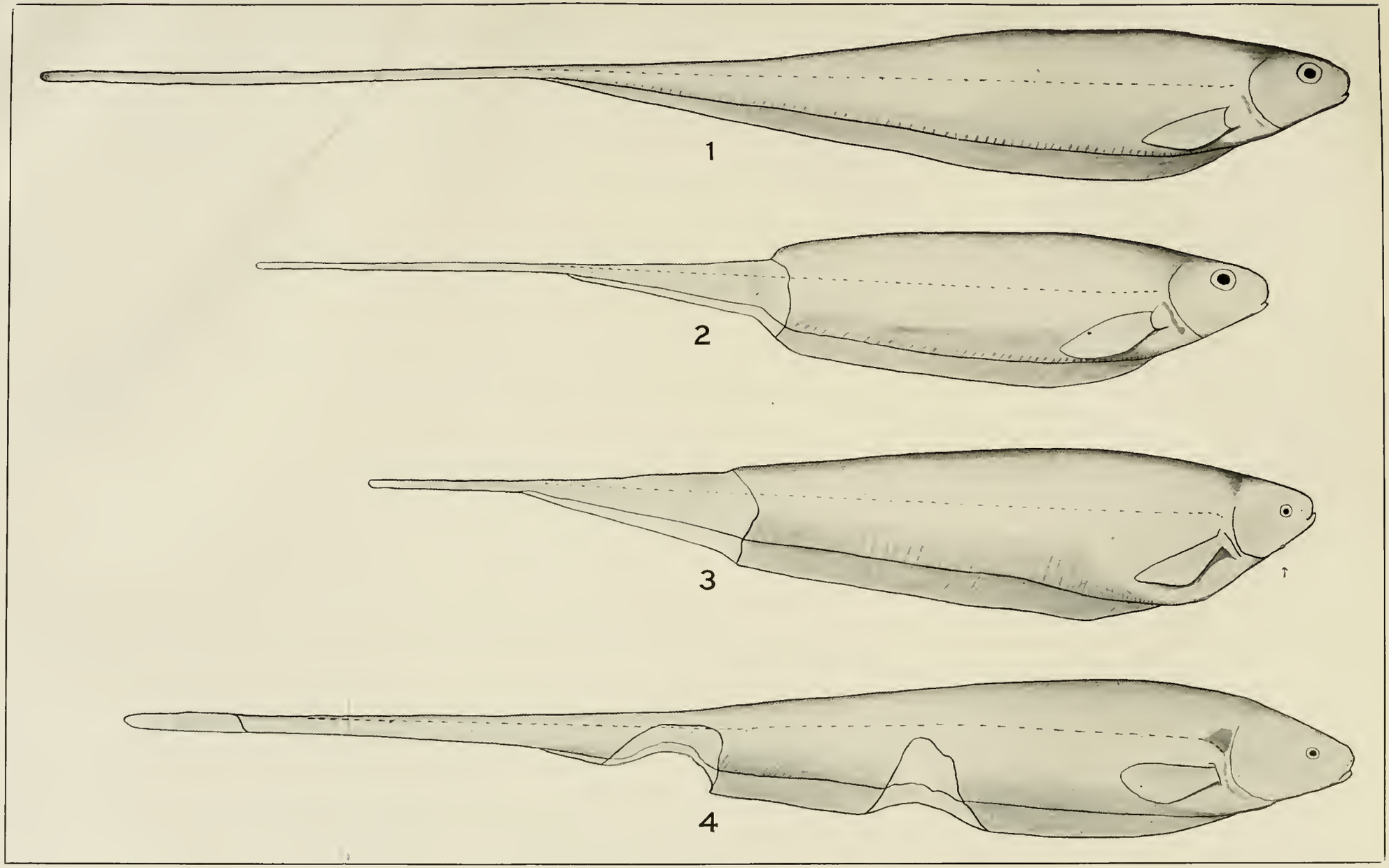


FIG. 1. OUTLINE OF *Eigenmannia macrops* (BLGR.) NORMAL. FIG. 2. MAXIMUM REGENERATION FOUND IN *E. macrops* (I. U. Cat. No. 12601). FIG. 3. MAXIMUM REGENERATION FOUND IN *Eigenmannia virescens* (VAL.), (I. U. Cat. No. 12604). FIG. 4. THREE INJURIES ON A 500 MM. *Sternopygus macrurus* (BL. & SCHNEID.), (I. U. Cat. No. 12592).

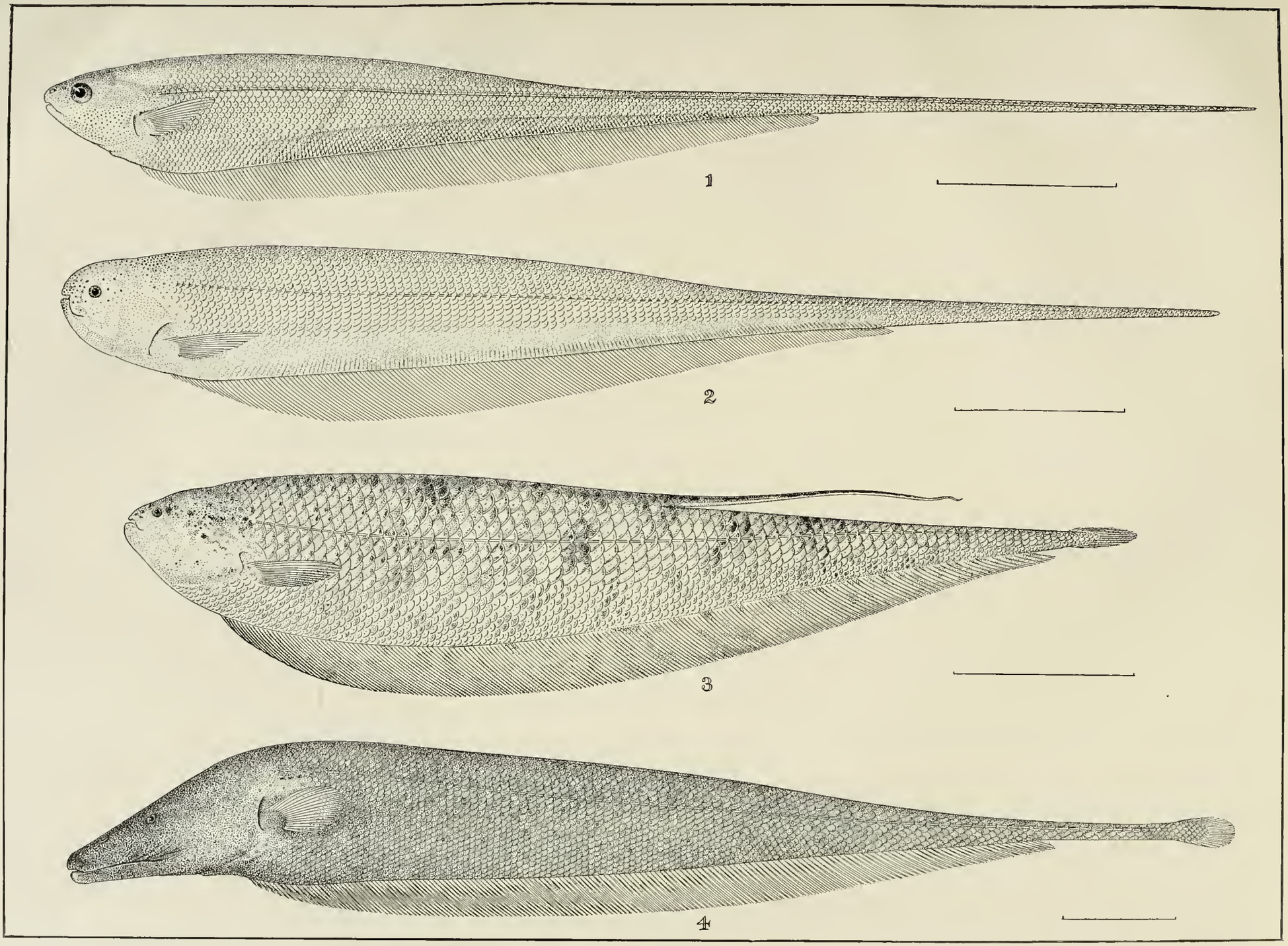


FIG. 1. *Eigenmannia macrops* (BOULENGER) 170 mm., C. M. Cat. No. 1805. FIG. 2. *E. troscheli* (KAUP) 175 mm., C. M. Cat. No. 3164. FIG. 3. *Adenosternarchus sachsi* (PETERS) 140 mm., C. M. Cat. No. 3199. FIG. 4. *Sternarchus leptorhynchus* ELLIS (TYPE) 260 mm., C. M. Cat. No. 1763.

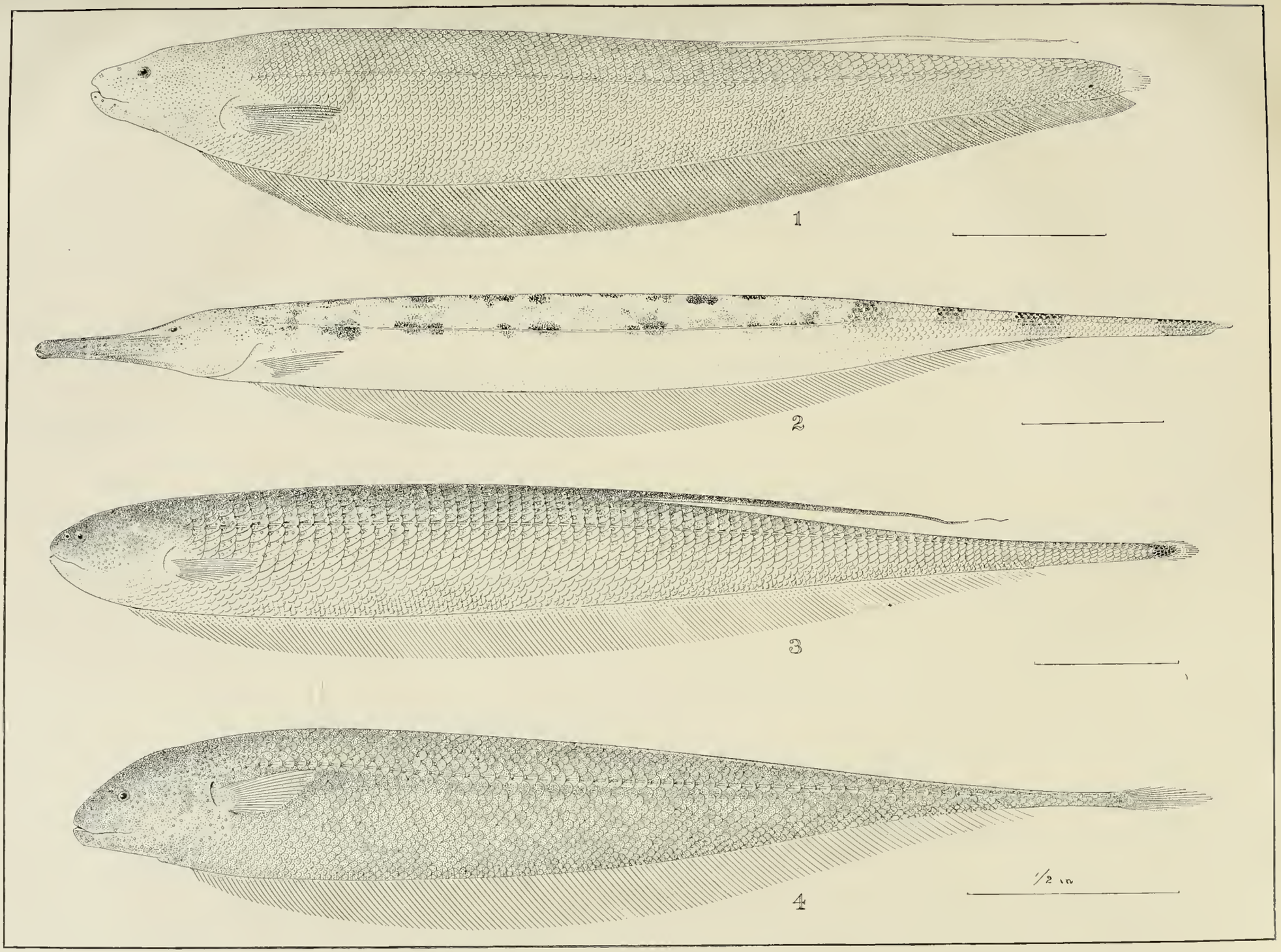


FIG. 1. *Sternarchus hasemani* ELLIS (TYPE) 170 mm. to Base of Caudal. C. M. Cat. No. 3191. (Caudal and Part of Peduncle Regenerated). FIG. 2. *Gymnorhamphichthys hypostomus* ELLIS (TYPE) 215 mm., C. M. Cat. No. 3182. FIG. 3. *Porotergus gimbeli* ELLIS (TYPE) 200 mm., C. M. Cat. No. 3197. FIG. 4. *Porotergus gymnotus* ELLIS (TYPE) 70 mm., C. M. Cat. No. 1759.

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CARNEGIE MUSEUM.

VOL. VI. NO. 4.

W. J. HOLLAND, EDITOR.

RECORD OF THE FISHES OBTAINED IN JAPAN IN 1911

By DAVID STARR JORDAN AND WILLIAM FRANCIS THOMPSON

PITTSBURGH.

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. 4.

RECORD OF THE FISHES OBTAINED IN JAPAN IN 1911.

By David Starr Jordan and William Francis Thompson.

(Plates XXIV–XLII.)

The senior author spent the summer and autumn of 1911 in Japan and Korea in the interest of International Conciliation under the auspices of the World Peace Foundation.

His naturalist friends in Japan at once began to make collections of fishes for him, at the same time cheerfully assisting him in his efforts to study the fishes in the scant leisure which his other occupations allowed. A large collection was obtained and through the courtesy of Mr. Asano and Mr. Shiraishi of the Toyo Kisen Kaisha delivered without charge in California. About three hundred and ninety species were obtained in Japan. This collection which forms the subject of this paper is shared between the Carnegie Museum at Pittsburgh, and Stanford University. The types are in the former institution, as the new species are published under its auspices.

The collection consists of the following:

1. A large collection made by Mr. Alan Owston of Yokohama, covering various localities in Japan, the most valuable materials being dredged by him in his steamer, the "Golden Hind." Many valuable specimens from Mr. Owston's collections were obtained by Jordan and Snyder in 1900. Other new species obtained from him have been described by Mr. Shigeho Tanaka, and by naturalists in Europe.

2. A collection made at Misaki by Mr. Kumakichi Aoki, fisherman at the Seaside Laboratory of the Imperial University of Tokyo, under the direction of

Professor Ijima. Mr. Aoki is the most accomplished collector of fishes in Japan, and his services to Jordan and Snyder in 1900 were invaluable.

3. Collections made by Dr. Jordan assisted by Mr. M. Sagimoto, director of the Zakoba market in Osaka, and by a former student, Mr. Miehitaro Sindo, in Kobe. These collections were mostly from Osaka, partly from the Yodo River, and partly from the deep-water nets of the trawling fleet, which operates in the Straits of Tsushima between Shimonoseki and Fusan.

4. Collections made by Dr. Jordan at Matsubara on Lake Biwa with the aid of Mr. Kogetsuko Nakagawa, a local fisherman.

5. Collections made about Nagoya by Mr. Kingsbury, principal of a mission-school, and his pupils.

6. Collections made about Okayama by Mr. K. Kusano and Mr. Y. Otaki.

7. A collection made by a former student of Dr. Jordan, Mr. Yoshiro Manabe, teacher of science in the Kwansei Gakuin (college) at Kobe.

8. Collections made by Dr. Jordan about Sendai and Matsushima Bay with the aid of Mr. T. Takamura of the Sendai Museum.

9. Collections made by Dr. Jordan and Mr. Manabe at the island of Awaji near Kobe.

10. Collections made by Dr. Jordan in the markets of Tokyo, Yokohama, and Shimonoseki.

Of these collections those obtained through the help of Mr. Owston and of Mr. Aoki are vastly more important than the others.

A few species seen and here recorded were for one reason or another not secured in the collection. The following are described as either generically or specifically new:

Alepocephalus umbriceps, No. 6030.[1]
Nansenia ardesiaca, No. 6023.
Gnathopogon ishikawæ, No. 6029, Cotypes.
Acheilognathus tabira, No. 6007,
Acheilognathus moriokæ,
(*Metzia*)* *mesembrina*,
Acanthorhodeus atremiuus,
Acanthorhodeus scioscmus,
Rhodeus kurumeus, No. 5011,
(*Tanakia*) *oryzæ*,
Cephalopholis boninius, No. 6038.
(*Franzia*) *nobilis*, No. 6452.
Franzia ardens, No. 6451,
Xyrichthys sciistius, No. 6028,
Sebastodes owstoni, No. 6026,
Thysanichthys evides, No. 6019,
Careproctus burkei, No. 6457,
Careproctus gilberti, No. 6456,
Chelidonichthys ischyrus, No. 6459,
Synchiropus ijimæ, No. 6015,

[1] The numbers following the names of species in this paper are the catalog numbers of the specimens in the Carnegie Museum as supplied by Dr. C. H. Eigenmann (*W. J. Holland*).

* Generic names in parentheses are new (*W. J. Holland*).

Pseudaspius atrilatus, No. 6012,
Solenostomus pægnius, No. 6020,
(*Ectenias*) *brunneus*, No. 453,
(*Icticus*) *ischanus*, No. 6036,
Amia sialis, No. 6021,
(*Calymmichthys*) *xenicus*, No. 6027,
(*Spectrunculus*) *radcliffei*, No. 6061.
Lycodes tanakæ, No. 6004,
Coryphænoides bona-nox, No. 6462,
(*Tarphops*) *oligolepis*, No. 6010.

The following additional species are for the first time recorded from Japan:

Diaphus cæruleus (Klunzinger), No. 6603a–g.
Lutianus quinquelineatus (Bloch), No. 6349a.
Plectorhynchus pica (Cuvier & Valenciennes), No. 6018a,
Chætodon setifer Bloch, No. 6152a,
Chætodon vagabundus Linnæus, No. 6138a,
Tilesina gibbosa Schmidt, No. 6022a–f,
Ostracion fornasini Bianconi,
Neobythites fasciatus Radcliffe, No. 6206a.

Most of the new figures in this paper are the work of Mr. William Sackston Atkinson. A few are by Mrs. Anna Brown Nash. Others are reproduced from papers in the Proceedings of the United States National Museum. We are indebted to Mr. Charles William Metz for important aid in the determination of species.

Family PETROMYZONIDÆ.

1. **Lampetra mitsukurii** Hatta.
   Lake Biwa, at Matsubara, 6103a–b.

Family GALEORHINIDÆ.

2. **Mustelus manazo** Bleeker.
   Shimonoseki.
3. **Mustelus griseus** Pietschmann.
   Osaka, 6358a.
4. **Triakis scyllium** Müller & Henle.
   Osaka, 6359a.

Family SPHYRNIDÆ.

5. **Sphyrna zygæna** (Linnæus).
   Osaka, 6361a.

Family LAMNIDÆ.

6. **Isuropsis glaucea** (Müller & Henle).
   Tokyo Market; two seen, not taken.

Family SQUALIDÆ.

7. Deania eglantina Jordan & Fowler.

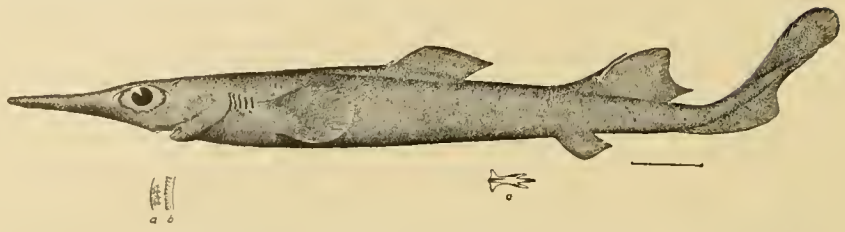


Fig. 1. *Deania eglantina* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXVI, p. 632).

Misaki. A large example, otherwise like the type. Head 4.125 in length, eye 7. The validity of the genus *Deania,* which is related to *Centrophorus,* has been questioned.

Family NARCOBATIDÆ.

8. **Narce japonica** (Temminck & Schlegel).
   Tokyo, No. 6393a.

Family RAJIDÆ.

9. **Raja meerdervoorti** Bleeker.
   Misaki, Nos. 6173a–b. (Mem. Carn. Mus., Vol. VI, p. 5, fig. 3).
10. **Raja kenojei** Müller & Henle.
    Schinabara, Misaki, No. 6183a.

Family DASYATIDÆ.

11. **Urolophus fuscus** Garman.
    Osaka.

Family DOROSOMATIDÆ.

12. **Konosirus punctatus** (Temminck & Schlegel).
    Nagoya, Nos. 6020a–c; Misaki, No. 6448a.

Family CLUPEIDÆ.

13. **Stolephorus japonicus** (Houttuyn).
    Misaki, Nos. 6248a–g.
14. **Harengula zunasi** (Bleeker).
    Osaka, Nos. 6178a–e.
    Adipose eyelid not obsolete; depth 3.4 in length; eye 3.5 in head.
15. **Ilisha elongata** (Bennett).
    Osaka.

Family GONORHYNCHIDÆ.

16. **Gonorhynchus abbreviatus** Temminck & Schlegel.

Misaki, No. 6033a, the third specimen known. 240 mm. in length; identical with the one described by Jordan & Herre.

Compared with *Gonorhynchus gonorhynchus* from Port Jackson, Australia, the eye is larger, the head longer, the depth greater, the pectoral longer, and there is one ray less in dorsal and anal. Head 4.25 in body; depth 7.5; D. 11; A. 8. Eye 4 in head, snout 2.5; interorbital 4; pectoral 5 in body. Scales 162–42. In *G. gonorhynchus*, the head is 4.66 in length, the depth 8.66. D. 12; A. 9. Scales 161–48.

Family ALEPOCEPHALIDÆ.

17. **Alepocephalus umbriceps** sp. nov. (Plate XXIV, fig. 1.)

A single specimen from Aomori. 270 mm. in total length. Type No. 6030a, Catalog of Fishes, Carnegie Museum.

Head 2.75 to base of caudal; depth at pectorals 5.33; eye equal to snout, 4 in head; maxillary 2.66; D. 17; A. 17; P. 11; branchiostegals 7; 65 pores in lateral line.

Head very large, nearly as deep as body, which is deepest at pectorals; bony interorbital space, 6.5 in head; postorbital length of head equal to half its whole length; maxillary ending under center of eye; jaws equal; teeth in single series on premaxillaries, of small size, not canine-like; a row of very delicate and minute teeth on lower edge of maxilla, not visible to naked eye as teeth; close-set cardiform series in lower jaw of same size as those on premaxillaries; palatines ridge-like, set on edge with narrow band of similar teeth; gill-rakers 7+19, longest one-third diameter of eye.

Dorsal inserted over anus, which is midway between edge of opercle and base of middle caudal ray, and its base 2.5 in head; caudal forked, central rays half length of longest, tenth or eleventh ray longest, counting rudimentary rays from either edge; each edge continued on caudal peduncle by a thin fold of skin half-way to last dorsal and anal rays; anal inserted under third or fourth dorsal ray, and terminating a quarter of the length of the eye behind last dorsal ray; both anal and dorsal on fleshy bases; ventral inserted nearly midway between pectoral and anal insertion, its length slightly greater than diameter of eye; pectoral small, 2.8 in head.

Scales imbricate, deciduous, bases narrower than tips, sides straight; concentric lamellæ distinctly visible to naked eye; scales present on bases of vertical fins; head entirely scaleless, covered with loose skin.

Color of head dense black, each scale of body tipped with black; all fins black; mouth-cavity and peritoneum black.

Family MICROSTOMATIDÆ.

18. Nansenia ardesiaca Jordan & Thompson, sp. nov. (Plate XXIV, fig. 2.)

(*Nansenia grœnlandica* Tanaka, *non* Reinhardt.)

This species is well figured by Tanaka.

Description of a specimen (No. 6023a) 190 mm. in total length, taken in three hundred and fifty fathoms at Okinose, in Sagami Bay, Alan Owston collection:

Head 4.5 in body, 5 in total length; body-depth 8 in body-length; eye 2.33 in head; snout 6.5; maxillary 4.5; interorbital space 4; dorsal rays 10; anal 10; pectoral 12; ventral 12; scales in lateral line 55 (five of which are on caudal); from center of breast to middorsal line 8 (counting lateral line); gill-rakers 12+25.

Body elongate, subcylindrical, greatest depth from between posterior margin of eye to insertion of dorsal fin; caudal peduncle half this depth. Eyes very large, projecting somewhat above dorsal profile of head and approaching ventral profile; snout very short and blunt; lower jaw somewhat projecting; mouth opening obliquely; line of maxillary approaching vertical; maxillary covered by anterior end of pre-orbital, reaching slightly behind anterior margin of eye; teeth small, conical, in a single rather thick-set row in each jaw, none enlarged or canine-like; vomer and palatines toothless; interorbital space broad, concave; suborbital and opercular bones thin and flexible; latter with emargination above angle, leaving open passage to gill-cavity.

Dorsal fin inserted slightly before middle of distance between snout and base of caudal, its base half the length of the fourth ray, which is equal to the distance from the tip of snout to posterior border of eye; ventrals inserted slightly behind last dorsal ray, length equal to fourth dorsal ray; anal inserted nearer caudal base than tips of ventrals, longest ray less than diameter of eye; pectorals narrow, first and twelfth rays simple, others branched, longest ray 1.75 in head; adipose fin small, inserted above posterior half of anal fin, its length 2.33 in eye. Caudal 1.5 in head, forked, but not deeply.

Scales large, thin, loosely attached; base of scales coarsely serrate, each basal radius projecting; circuli parallel to serrated edges, forming acute angles to correspond to teeth of base; circuli very fine and numerous. Tube of lateral line very large, its breadth a fourth of that of its scales; pores large, single; lateral line continued beyond base of caudal as an appendage formed of six or seven successive scales and attached only at the base to caudal ray. Lateral line tube continued over dorsal surface of head to snout, over the occiput and along lower margin of eye.

Color brilliant silvery; dusky on snout, jaws, opercular plate, and bases of caudal and ventrals; scales of a bright, silvery appearance. Along the center of

the back from the occiput to the insertion of the dorsal is a rather firm rod of tissue immediately below the skin. Having but the single specimen, we are unwilling to dissect it to ascertain the nature of this structure.

This is probably distinct from *Nansenia grœnlandica* described from a single specimen from Greenland, but Reinhardt's scanty account indicates no certain difference.

Family SALMONIDÆ.

19. **Oncorhynchus keta** (Walbaum).

(Mem. Carn. Mus., Vol. VI, p. 9, fig. 8).

Sendai.

A breeding male, weighing 8 pounds; greenish, side silvery, barred with dirty crimson; no spots; top of dorsal black; A. 14, D. 12 or 13. Gill-rakers 10+13. Scales 130. Pyloric cæca about 100. Flesh orange, rather soft, becoming pale and mushy when cooked, palatable, but, at the best, much inferior to that of the Masu.

This species, the Dog Salmon or Calico Salmon of Alaska, is the large salmon or Sake of Japan. It is very extensively salted, the flesh when salted being quite red. It ranges southward as far as the Tonegawa, north of Tokyo. No specimen in the Carnegie Museum.

20. **Oncorhynchus masou** (Brevoort). (Plate XXIV, fig. 3.)

(*Salmo macrostomus* Günther).

Lake Biwa, Sendai, Lake Chuzenji (planted in latter locality). No. 6002a.

The Masu, the young being called Yamame or Yamabe, is a species close to the Silver Salmon (*O. kisutch*) of Alaska. It is common as far south as Lake Biwa, and is sometimes landlocked, as in Lake Chuzenji, where it has been artifically introduced. This is a true *Oncorhynchus*, all its individuals dying after spawning. There is no true trout, that is, no species of *Salmo*, native in Japan.

The salmon called *Oncorhynchus yessoënsis* is not known to the Japanese Bureau of Fisheries and is probably not different from *O. masou*. *O. kisutch* is not certainly known from Japan, the specimens thus far called by that name being *O. masou*. Mr. Tokishiro Koshida of the Bureau of Fisheries informs us that the king Salmon, *Oncorhynchus tschawytscha*, known as "Masunosuke," or Lord of the Salmon, is found in Nemuro and occasionally as far south as Hakodate.

The "Benimasu" or Red Salmon, *Oncorhynchus nerka*, is common in Nemuro and landlocked in the lakes of that region. *Oncorhynchus masou* is known in Lake Chuzenji as "Hinemasu." It was introduced there from Akita, and has become landlocked.

Gill-rakers long, 9+15 to 18; scales 133. A. 14; D. 13; vomer with seven or eight sharp teeth.

Color olive, sides silvery; back with two or three irregular rows of brown spots, a few on dorsal, some at base, some on upper part of caudal, none on adipose fin. The sides turn red in fall.

Another specimen, a male, somewhat hook-nosed. A. 14, besides rudiments. Gill-rakers 8+17. Caudal forked; tip of dorsal paler, not black. Adipose fin large. Unspotted bases of fins dark. Dorsal and caudal with some black spots; back with spots; spots along base of dorsal; pyloric cæca few, not over forty to fifty. Weight three or four pounds.

21. **Plecoglossus altivelis** Temminck & Schlegel.

(Mem. Carn. Mus., Vol. IV, p. 167, fig. 3; *l. c.* Vol. VI, p. 10, fig. 9).

Matsushima, Nos. 6257a–b; Okayama, Nos. 6101a–g; Lake Biwa at Matsubara, Nos. 6409a–f; Yodo River, near Osaka, Nos. 6315a–c.

Family SALANGIDÆ.

22. **Salanx microdon** Bleeker.

Matsushima Bay, Nos. 6065a–f.

Depth eight to eleven inches in length.

Family AULOPIDÆ.

23. **Aulopus japonicus** Günther. (Plate XL, fig. 1).

Misaki, No. 6461.

Family SYNODONTIDÆ.

24. **Saurida argyrophanes** (Richardson).

Osaka, Nos. 6332a–c; three specimens, the longest being 250 mm. in length, as long as the types of *Saurida eso*. Scales 47–54. Misaki, Nos. 6306a–b; Shimonoseki, No. 6194a.

25. **Saurida eso** Jordan & Herre.

(Mem. Carn. Mus., Vol. VI, p. 12, fig. 12).

Osaka, No. 6323a. Length 264 mm. Scales 63. In *S. argyrophanes*, the scales are always larger. Shimonoseki, No. 6162a.

26. **Synodus japonicus** (Houttuyn).

Kobe, No. 6085a.

27. **Trachinocephalus myops** (Forster).

Kobe, Nos. 6231a–b; Misaki, Nos. 6193a–b.

Family MYCTOPHIDÆ.

The Japanese species of this family are described in a preceding paper by Professor Gilbert. The following were obtained by us from Mr. Owston's dredgings with the "Golden Hind."

28. **Dasyscopelus orientalis** Gilbert.
(Mem. Carn. Mus., Vol. VI, Pl. XI, fig. 1).
Misaki, No. 4613 type, 4614a–z, 4615; 4616.

29. **Diaphus gigas** Gilbert.
(Mem. Carn. Mus., Vol. VI, Pl. XII, fig. 2).
Sagami Bay, No. 4602a.

30. **Diaphus cæruleus** (Klunzinger).
Sagami Bay, Nos. 4603a–g.

31. **Diaphus latus** Gilbert.
(Mem. Carn. Mus., Vol. VI, Pl. XIII, fig. 1).
Sagami Bay, No. 4604 type, 4605a–d.

32. **Diaphus sagamiensis** Gilbert.
(Mem. Carn. Mus., Vol. VI, Pl. XIII, fig. 2).
Sagami Bay, No. 4608 type, 4609a–c.

Family SILURIDÆ.

33. **Parasilurus asotus** (Linnæus).
(Mem. Carn. Mus., Vol. IV, fig. 4, p. 168; *l. c.*, Vol. VI, fig. 13, p. 12).
Okayama, Tama River, near Tokyo, Nos. 6440a–b; Lake Biwa, Nos. 6291a–e.

34. **Liobagrus reini** Hilgendorf.
Lake Biwa at Matsubara, No. 6125.

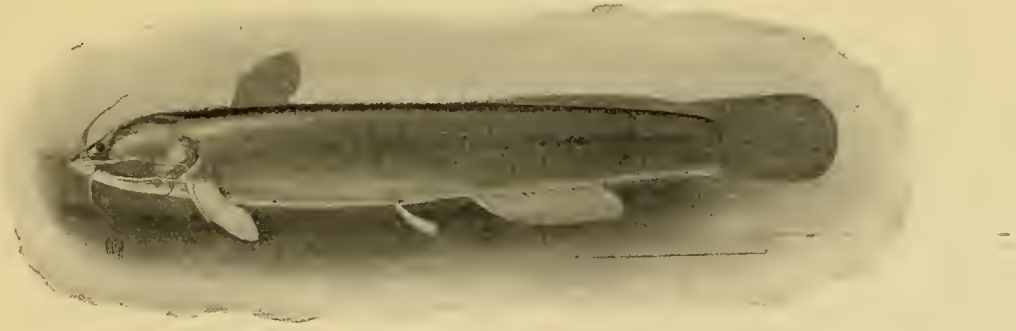


Fig. 2. *Liobagrus reini* Hilgendorf. (From Proc. U. S. N. M., Vol. XXVI, p. 910).

Depth 6 in total; eye 4 in interorbital; spines of fins not half length of soft rays.

5. **Fluvidraco nudiceps** (Sauvage).
Lake Biwa at Matsubara. Nos. 6275a–b. Young piebald; fins dark; a white caudal spot.

36. **Pseudobagrus aurantiacus** (Temminck & Schlegel).
Near Tokyo, No. 6422a.

Family PLOTOSIDÆ.

37. **Plotosus anguillaris** Lacépède.
Misaki, 6222a–b, 6352 many; Goto Islands, 6421a.

Family COBITIDÆ.

38. **Misgurnus anguillicaudatus** (Cantor).
(Mem. Carn. Mus., Vol. VI, p. 14, fig. 15).
Nagoya; Yodo River, at Osaka 6284 many; Lake Biwa, at Matsubara, Nos. 6080a–b.

39. **Hymenophysa curta** (Temminck & Schlegel).
Lake Biwa, at Matsubara, No. 6097a. Body with eight transverse black bars, the first on the occiput; two others on the caudal; those on the body broadest above and fading out entirely on the ventral region; fifth bar continuous with black base of dorsal; a light bar across dorsal fin, the fin otherwise black with a clear edge; anal with a black submarginal shade. Caudal with two dark cross-bars, the first across its base, with a central blotch; each lobe tipped with black. The colors in life have not hitherto been fully described.

40. **Cobitis tænia** Linnæus.
Okayama, Nos. 6112a–c. Nos. 6096a–f, Lake Biwa.
The Japanese species, if distinct from the European *C. tænia,* is *Cobitis biwæ* Jordan & Snyder.

Family CYPRINIDÆ.

41. **Hemibarbus barbus** (Temminck & Schlegel).
Matsubara, on Lake Biwa, No. 6232a.

42. **Pseudogobio esocinus** (Temminck & Schlegel).
Lake Biwa, at Matsubara, Nos. 6399a–b, Okayama.

43. **Sarcocheilichthys variegatus** (Temminck & Schlegel).
Lake Biwa, at Matsubara, No. 6333 many.

44. **Gnathopogon gracilis** (Temminck & Schlegel).
(*Leucogobio biwæ* Jordan & Snyder.)
Lake Biwa, at Matsubara, No. 6064a.
The genus *Gnathopogon* of Bleeker is identical with *Squalidus* of Dybowsky and *Leucogobio* of Günther, both later names. *Leucogobio biwæ* seems to be the same as *Capoeta gracilis* of Schlegel, which, according to Schlegel's figures and description,

has the depth 5.5 in length to fork of caudal, the barbel a little longer than in *G. elongatus*, the pectorals extending nearly to the ventrals, the vent well-removed from the anal fin, and the scales 4–35–5.

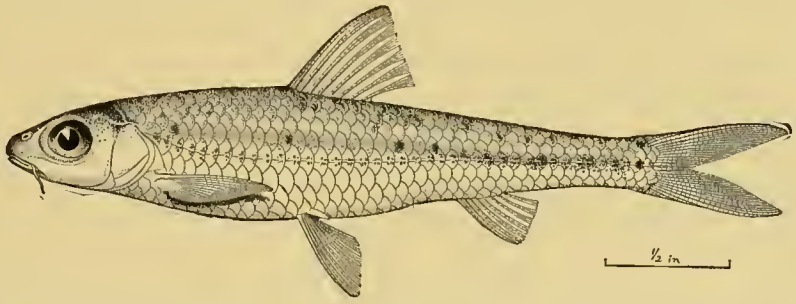


Fig. 3. *Gnathopogon gracilis* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXIII, Pl. IX, fig. 1).

45. **Gnathopogon elongatus** (Temminck & Schlegel).

(*Leucogobio güntheri* Ishikawa).

Lake Biwa, at Matsubara; Nagoya; No. 6161 many, Yodo River, at Osaka.

The specimens from Lake Biwa, described as *Leucogobio güntheri* by Jordan and Fowler, correspond entirely to Professor Ishikawa's account of the species. The *Capoeta elongata* of Schlegel is certainly the same, agreeing in the deep caudal peduncle and the short pectoral, not extending half way to ventrals. Depth 4 in body; barbel long; scales thirty-eight.

46. **Gnathopogon mayedæ** (Jordan & Snyder).

(*Leucogobio mayedæ* Jordan & Snyder).

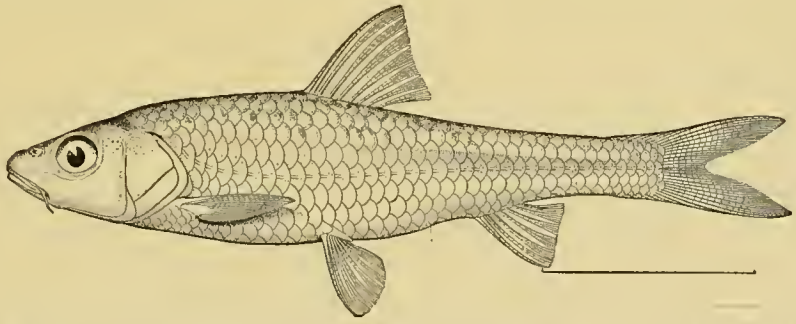


Fig. 4. *Gnathopogon mayedæ* (Jordan & Snyder). (From Proc. U. S. N. M., Vol. XXVI, p. 828).

Lake Biwa, at Matsubara, No. 6134a. The males bear an overgrowth about the mouth, placed as are the tubercles in *Acheilognathus*.

47. **Gnathopogon ishikawæ** sp. nov. (Plate XXIV, fig. 4).

The description is of type and cotypes, Nos. 6014–c, C. M., altogether fifteen in number from the Chikugo River at Kurume, collected by Jordan and Snyder in

1900, the largest breeding female, sixty-three millimeters in total length, being taken as the type.

Head 3.14 in length of body to base of caudal (50 mm.); depth equal to head; D. III, 7; A. II, 6; scales in lateral line 34; in transverse series between insertions of vertical fins 3.5–2.5; pharyngeal teeth 5, 2–2, 5.

Snout slightly longer than eye, which is 3.75 in head; tip of premaxillaries at, or below, level of lower margin of orbit; mouth but little oblique; barbel long, one-half to two-thirds diameter of eye, its base under the posterior nostril; maxillary ending under the anterior margin of the eye; distance from snout to occiput 5 in body length; gill-rakers very short and soft, 2 or 3 on each limb of first arch; pharyngeal teeth smooth, unserrated, the tips bent toward the lateral surface of each tooth, a grinding surface present; breadth of body more than half its depth, which is greatest at the insertion of the dorsal and slopes evenly to the rather deep caudal peduncle, the length of which is contained 1.33 in head and its depth 2.5 in head.

Dorsal inserted, as in all known species of the genus, nearer the snout than the base of the caudal by the length of the former; its margin straight, each ray extending beyond the following one when supine, the first branched ray the longest, 1.12 in head; anal inserted under twenty-second scale of lateral line and beyond tip of dorsal rays, its margin straight, the tips coinciding when supine, extending more than half the distance between last anal ray and the first of the caudal, the length of the longest ray 1.6 in the head; pectorals extending more than two-thirds of the distance to the base of the ventrals, failing to reach them by the diameter of the pupil, their length nearly equal to the distance between the snout and the occiput; ventrals reaching anus, their length less than that of the pectorals by half the diameter of the pupil, the anus removed from the first anal ray by two-thirds the diameter of the eye, and by two and one-half scales; caudal nearly equal to length of head.

Lateral line but slightly decurved, complete; scales of middle line of back much enlarged, especially behind the dorsal, where they are slightly over twice the diameter of those on either side of them; before the dorsal there are three rows between the central row and the lateral line, while behind the dorsal there are two.

Color-pattern lacking, save for a spot of dark at the base of the first dorsal rays; space above the lateral line with irregular spots the size of the scales, the edges of which are occasionally pigmented; scales of the lateral line in the type pigmented where overlapped by the preceding scales; an indistinct dark line or stripe along side behind dorsal, continued anteriorly in an unpigmented space; caudal spot lacking; peritoneum silvery, with small spots of black.

This species is most closely related to *Gnathopogon mayedæ*, from which it may be at once differentiated by the longer barbel and the extension, when supine, of the anal rays, more than half-way from the last anal ray to the first caudal ray. Other differences are the scales enlarged in the middle line of the back, the presence of one more series of scales above the lateral line, the slightly shorter distance from the tip of the snout to the occiput, the longer ventrals, and deeper caudal peduncle.

Among the cotypes are both males and females, with ripe gonads. The male is distinguished from the females by the presence of a smooth overgrowth on the front and sides of the snout. The eggs are small, as in others of the genus, being about half a millimeter in diameter. As the female, which was taken as the type, is the most strongly pigmented of any of the specimens, it is probable that the males are not, as a rule, colored more highly than the females.

Among the specimens recorded by Jordan and Snyder from Lake Biwa as *Leucogobio mayedæ* there are a number of specimens of this species, all of them very small. Nos. 6009a–c Lake Biwa.

This species is named for Professor Chiyomatsu Ishikawa, of the Imperial University of Tokyo, who early studied the fishes of Lake Biwa.

KEY TO JAPANESE SPECIES OF *Gnathopogon*.

a. Anus distant but the breadth of one scale from first anal ray; pectoral extending less than two-thirds of distance to ventrals; gill-rakers numerous, 4+9 or 10; body-depth 4.

b. Caudal peduncle deep, 8.5 in body; barbel long, three-fifths of diameter of eye; scales 36 to 38; pharyngeal teeth only occasionally and slightly serrate.....*clongatus*.

bb. Caudal peduncle slender, about 10 in body; barbel short, one-fourth of diameter of pupil; scales 42; pharyngeal teeth constantly and strongly serrate on grinding surface.....*jordani*.

aa. Anus distant at least 2.5 scales from first anal ray (two-thirds of eye); pectoral extending more than two-thirds distance to ventrals; gill-rakers short and rudimentary, 3 or 4+4, lacking anteriorly.

c. Depth 4 in body; anus 2.5 scales (two-thirds diameter of eye) distant from first anal ray.

d. Scales in middle line of back enlarged; rows between lateral line and dorsal 3.5; anal rays extending over half-way from base of last to first caudal rays; maxillary not reaching beyond orbit, its barbel under nostril; barbel two-thirds of eye.....*ishikawæ*.

dd. Scales in middle line of back not enlarged; rows between lateral line and dorsal 4.5; anal rays not extending half-way to first caudal rays; maxillary reaching beyond orbit; its barbel short, less than pupil.....*mayedæ*.

cc. Depth 6 in body-length; anus distant the breadth of 4.5 scales (1.16 times diameter of eye) from insertion of anal fin; 5 scales above lateral line; barbel one-half diameter of eye; scales in middle line of back but slightly enlarged.....*gracilis*.

48. **Acheilognathus rhombeus** (Temminck & Schlegel).

Lake Biwa, at Matsubara, No. 6327 many.

Capoeta rhombea Schlegel, Fauna Japonica, Poiss., 1846, p. 205, pl. C., fig. 6; near Nagasaki.
Acheilognathus rhombeus Bleeker, Prodr. Cypr., 1, 1860, p. 255.

Paracheilognathus rhombeus Bleeker, Atl. Ichthyol. Cypr., 1863, p. 33.

Aehilognathus rhombeus Günther, Cat. Fish., VII, 1868, p. 279; Nagasaki, from one of Schlegel's types; Ishikawa, Prel. Cat., 1897, p. 12; Tokyo, Lake Biwa, Yamashiro.

Paracheilognathus rhombea Jordan and Fowler, Proc. U. S. N. Mus., Vol. XXVI, 1903, p. 815, Lake Biwa, Yodo River, Chikugo River, Funayado; Lake Yogo, Tanaka, Ann. Zoöl. Jap., VII, Part. 1, 1908, p. 2; Lake Biwa, at Katata and Iba.

Acheilognathus rhombeum Jordan & Snyder, Proc. U. S. N. M., XXIII, 1901, p. 343; Lake Biwa.

Achilognathus steenaekeri Sauvage, Bull. Soc. Philom., Paris, 1883, p. 3; Lake Biwa.

Apparently the genus *Paracheilognathus* Bleeker, of which this species is type, characterized by the plicate teeth and the long dorsal, cannot be separated from *Acheilognathus*. The species of this genus, very numerous in Japan and China, are much alike in appearance and have been the object of much confusion.

This species is here described from numerous specimens from Lake Biwa and Chikugo, the longest 11.5 cm. in total length. These are in part those of Jordan and Fowler (Proc. U. S. Nat. Mus. XXVI, p. 815).

Depth 2.5 to 2.12 in body-length; D. III, 12 (11 to 14); A. II, 10 (9 or 10); scales in lateral line thirty-five to thirty-eight, in transverse series between insertion of vertical fins 6/5 or /6; pharyngeal teeth 5–5.

Head 4 in body-length; snout 3.56 in head; mouth horizontal, tip of premaxillaries level with lower edge of orbit; profile of snout arched at nostrils, that of occiput strongly depressed in adults; eye equal to snout or somewhat less; barbels very short, at most, eight times in eye; gill-rakers 4+11 on first arch, equal in length to barbels; pharyngeal teeth folded or plicate on the lower lateral face of each in a transverse direction, not truly serrate, with narrow grinding surface and hooked tip; depth of caudal peduncle slightly more than half the length of head, its length 1.25 in head.

Dorsal inserted midway between snout and base of caudal, its base 1.12 times length of head, its height nearly equal to head; outline of fin rounded, first rays not extending beyond base of last when supine; anal inserted under sixth branched dorsal ray, its base 1.5 in that of the dorsal, its height 1.5 in head, margin rounded, first rays not extending beyond base of last; pectorals and ventrals 1.5 in head.

Body dark above, especially on line of back; a blue-black stripe as wide as pupil arising abruptly at fourth scale from last in lateral line and extending forward to below first branched rays of dorsal; a blue-black spot just behind and above angle of opercle nearly as large as eye. Dorsal fin-rays with a white spot on each, halfway to tip, the membranes marked with a corresponding blue-black blotch, just behind white parts of rays; often a second row of white spots on rays distal to the others and separated by darker spaces, giving the appearance of two fine stripes;

anal similar; caudal dark; paired fins clear; peritoneum black; pharyngeal teeth with pigmented covering save on grinding surfaces.

The males of this species differ in no way from the females, save in a darker belly and the presence of tubercles on the snout, and in two patches which are separated from the large tuberculated area before the eyes by a deep fold. The extent of the patches is larger than in most of the other species, but very variable according to the breeding season.

49. **Acheilognathus longipinnis** Regan.

Acheilognathus longipinnis Regan, Ann. Mag. Nat. Hist., 1905, p. 364; Lake Biwa (Yamasabu River), Nagoya.

Nos. 6418a–b, Nagoya.

The following is a description of five specimens, four of them males, the longest 87 mm. in total length, from Lake Biwa, at Matsubara, collected by Dr. Jordan in 1911:

Depth 2.16 in body-length to base of caudal; D. III, 15; A. II, 14 or 15; scales in lateral line 36, in transverse series 6/6 (between insertions of vertical fins); pharyngeal teeth 5–5.

Head 4 in body-length; snout 4 in head, very short in appearance and with its dorsal profile strongly arched; dorsal profile of head depressed at occiput; caudal peduncle short, its length from last anal ray to last vertebra equal to length of head without snout, or 1.4 in head; its depth 2 in head; tip of the premaxillaries at, or below, the level of the lower edge of the pupil; mouth more oblique than usual, due to the short snout; eye longer than snout, 3 in head; barbel absent; gill-rakers 3+13 on first arch, comparatively long, and not much shorter anteriorly than posteriorly; pharyngeal teeth plicate transversely on the lower lateral surface of each tooth, the narrow grinding edge not serrate, tip hooked.

Dorsal fin inserted midway between tip of snout and base of caudal peduncle; third and longest dorsal ray 1.1 in head; margin of fin straight or slightly rounded, its base 2.86 in body-length; anal fin inserted under fifth or sixth dorsal ray, its margin somewhat falcate, its base 3.5 in body-length, its last ray reaching half the distance between its own base and that of the first caudal rays; pectorals reaching base of ventrals, equal to length of caudal peduncle; ventrals extending slightly beyond first anal ray, their length contained 1.33 in head.

Color of specimens preserved in formalin very pale, somewhat darker above the lateral line, especially in the case of the female, the line of back darkest; no lateral stripe, or shoulder spot; dorsal fin with two black lines running longitudinally along the center of the fin, alternating with pale lines, the margins of the fins in the males

with a narrow margin of intense blue-black; anal similarly colored, but with a broader margin of black and more distinct stripes of black and white; pectorals, ventrals, and caudal in female but slightly pigmented, the ventrals in the males of an intense black with the outer rays white; the belly of the males black from throat to anal fin, including the base of the pectorals, the area sharply separated from the colorless area above.

The males of this species differ from the females in color as shown above and also in the possession of paired tuberculated areas on the tip of the snout and an area with slightly smaller tubercles on the dorsal surface of the snout between the nostrils and above the anterior edge of the orbit.

The fact that this species does not possess a barbel does not exclude it from this genus, because *Acheilognathus cyanostigma* Jordan & Fowler possesses the merest rudiment. All of the group with plicate pharyngeal teeth possess very small barbels.

50. **Acheilognathus tabira** sp. nov. (Plate XXV, fig. 1).

Acheilognathus limbata Jordan & Fowler, Proc. U. S. N. M., XXVI, 1903, p. 818, Lake Biwa at Matsubara and Karasaki, and Lake Yogo; (not of specimens from Morioka, and not of Schlegel) Tanaka, Ann. Zoöl. Jap., VII, Part 1, 1908, Iba, Matsubara, and Kihama.

The types of this species are the original of the description of *Acheilognathus limbata* Jordan & Fowler, although the specimens utilized by them were mingled with *A. moriokæ* Jordan & Thompson. They are now in the collection of Stanford University.

Described from numerous specimens No. 6007a type, No. 6016, forty specimens from Lake Biwa at Matsubara, collected by Dr. Jordan in 1911 and by Jordan and Snyder in 1900, ranging in length from very young to 85 mm. in total length.

Depth 3.12 in body-length; D. III, 9 or 10; A. II, 9 or 10; scales in lateral line thirty-six or thirty-seven, in transverse series from first rays of vertical fins 6/5; pharyngeal teeth 5–5 (occasionally 6–5 or 5–6).

Head 4 in body-length; snout 3.66 in head; mouth very oblique, anterior edge of premaxillaries slightly above lower margin of pupil, the region of the articulation of the mandible prominent; profile of snout arched above nostrils, not at tip of snout, which it does not overhang; eye large; gill-rakers 2+7; pharyngeal teeth hooked, with narrow grinding surface, some of them always serrated or folded on the lower lateral surface, although all are not usually so; lateral line complete; barbel very minute, fine of texture, less than one-fourth diameter of eye in length; caudal peduncle slightly more than twice in head, its length 1.25; breadth of body 2 in head.

Dorsal inserted nearly midway between snout and base of caudal, its base 1.2 in head, its height (first rays) 1.5, these when depressed just reaching base of last ray; anal inserted under last dorsal rays, its base 1.5 in head, its margin nearly straight, tips of first rays not reaching base of last; height of first rays 1.66 in head; ventrals as long as anal rays, inserted under first dorsal ray; pectorals 1.25 in head.

Color plain, save for a blue-black lateral stripe along center of caudal peduncle, nearly half as wide as pupil, tapering to a point under center of dorsal, its broadest part on caudal peduncle, not reaching caudal; a sharply margined blue-black shoulder spot as large as pupil; dorsal with two clear stripes half way up the rays, alternating dark, the margin being dusky; anal similar; other fins colorless, save the dusky caudal; peritoneum black.

This species is very hard to distinguish superficially from *Acheilognathus moriokæ*, from which it differs in more oblique mouth, less falcate anal fin, larger eye, and less strongly marked coloration. The most striking difference is in the plication of the teeth.

All the males of this species in hand have lesser depth than the females; anal black, edged with white, ventrals black, the first two rays white; and the ventral surface of the belly black or pigmented.

Our only specimen from Okayama, a male, has a shorter caudal peduncle and smaller eye than any of our examples from Lake Biwa, and is much paler in color. One specimen from Nagoya has a similar caudal peduncle, but is in other respects similar to specimens from Lake Biwa.

"Tabira" is a vernacular name for these fishes about Lake Biwa.

51. **Acheilognathus cyanostigma** Jordan & Fowler.

Lake Biwa, at Matsubara, Nos. 6063a–d.

Acheilognathus cyanostigma Jordan & Fowler, Proc. U. S. Nat. Mus., XXVI, 1903, p. 820, Fig. 2; Lake Biwa, at Matsubara, and Lake Yogo, in Mino.—Tanaka, Ann. Zoöl. Jap., VII, Part 1, 1908, p. 3; Matsubara, on Lake Biwa.

The following is a description of the type and cotypes of this species in the ichthyological collection of Stanford University, with numerous other specimens from Matsubara, Lake Biwa.

Depth 3.33 in body-length to base of caudal; D. III, 8; A. III, 8 or 9; scales in lateral line 38, in transverse series between insertions of vertical fins 6/4; pharyngeal teeth 5–5.

Head 4; snout 3.7 in head; anterior edge of premaxillaries level with lower edge of pupil; mouth horizontal; gill-rakers 2+8, longest at angle, short and thick; pharyngeal teeth hooked, plicate on lower surfaces, usually a narrow grinding sur-

face; lateral line complete; barbel nearly obsolete, but present as a knob on end of maxillary; caudal peduncle slightly longer than usual, 4 in body-length, its depth 10 in body-length.

Dorsal inserted nearly midway between snout and base of caudal, its base 1.5 in head, its height 1.5; anal inserted under sixth branched ray of dorsal, its base 2

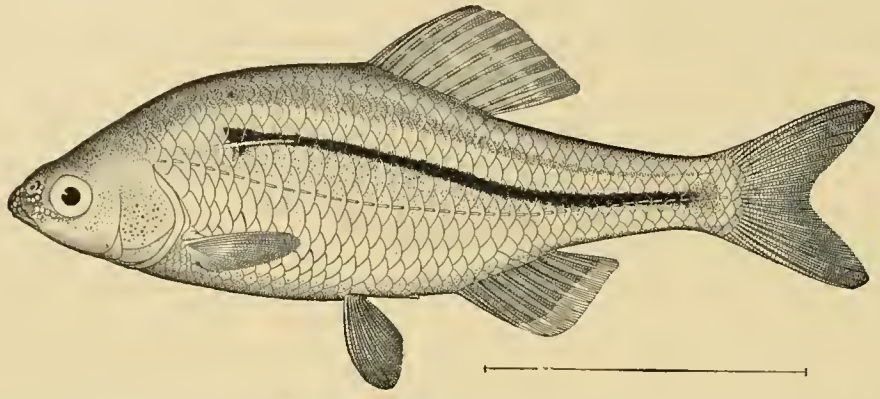


Fig. 5. *Achcilognathus cyanostigma* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXVI, p. 821).

in head, its height 1.66; its margin straight; pectoral 2 in body-depth; ventral equal to pectoral, inserted below origin of dorsal.

Color in alcohol plain, save for the lateral stripe of blue-black originating the width of a scale above the fifth or sixth scale of lateral line in a black spot as large as pupil and continued parallel to line of back to center of caudal, not reaching caudal fin; the anterior end of band frequently faint and the initial spot small; no shoulder spot; dorsal dusky, with a black line on first of distal half of rays, the black margined above and below by narrow white or clear stripes, the margin of fin sometimes touched with black; anal similar, but paler in strongly pigmented forms, with a broad margin of white; ventrals and pectoral clear, the former occasionally black.

52. **Acheilognathus limbatus** (Schlegel).

Capocta limbata Schlegel, Fauna Japonica, Poiss., 1846, p. 203, pl. C, Fig. 5; near Nagasaki.
Achilognathus limbatus Günther, Cat. Fishes, VII, 1868, p. 277; from one of Schlegel's types.
Acheilognathus shimasui Tanaka, Ann. Zoöl. Jap., VII, Part 1, 1908, p. 3; Tokiwa, on Lake Biwa.

Among the specimens recorded as *Acheilognathus lanceolatus* from Funayado, Kiusiu, Japan, by Jordan and Fowler, is a third species, evidently identical with *Capocta limbata* Schlegel.

The following description is based upon a specimen 56 mm. in total length, 44 mm. in body-length, and five smaller males and females, the smallest 34 mm. in body-length.

Depth 2.3 in body-length to last vertebra, D. III, 8; A. II, 10 or 11; scales in lateral line 33, in transverse series between insertions of dorsal and anal 6/4; pharyngeal teeth 5–5.

Head 4 in body-length; eye 3.12 in head, snout 4, with tubercles in breeding males; gill-rakers short, 2+7; pharyngeal teeth smooth, not plicate, hooked, with narrow grinding surface, without color; caudal peduncle strongly tapering, its length 1.3 in head, its depth 2; lateral line complete; barbel long, slightly shorter than snout.

Dorsal inserted nearer base of caudal than tip of snout, distance from snout to first ray 1.66 in body; dorsal base slightly less than four-fifths of length of head, its height 1.5 in head; anal inserted under second branched ray of dorsal, its base equal to that of dorsal; its height 2 in head, its margin straight; ventrals inserted before dorsal, their length slightly greater than anal height; pectorals 1.3 in head.

Color plain, without stripes or spots on body, although as a whole darker than usual and with the line of the back very dark; dorsal margined narrowly with black; a broad band of white below the margin as wide as pupil, the lower part so shaded as to form an indistinct dark band below the white; anal dusky, similar to the dorsal, but stripes less distinct, margin straight; ventrals and pectorals clear; peritoneum black.

This species is easily distinguished from all others of its genus in Japan by its greater depth, plain coloration, and fewer number of scales in the lateral line.

53. **Acheilognathus intermedius** (Temminck & Schlegel).

Lake Biwa, at Matsubara, No. 6258 many.

Capoeta intermedia Schlegel, Fauna Japonica, Pisces, 1846, p. 203, Pl. C, Fig. 4, near Nagasaki.

Acheilognathus intermedius Günther, Cat. Fishes, VII, 1869, p. 278, after Schlegel.—Sauvage, Bull. Soc. Philom., 1883, p. 3; Lake Biwa.—Ishikawa, Prel. Cat., 1897, p. 12; Tokyo, Yodo River at Kyoto; Maebara and Matsubara on Lake Biwa.

Acheilognathus melanogaster Bleeker, Act. Soc. Sci. Indo. Nederl., Japan, VI, p. 92, pl. 11, fig. 1, Tokyo.—Sauvage, Bull. Soc. Philom., 1883, p. 3; Lake Biwa.—Günther, Cat. Fishes, VII, 1868, p. 278, Tokyo, from Bleeker's types.—Ishikawa, Prel. Cat., 1897, p. 12, Lake Biwa, Owari.—Günther, Shore Fishes. Challenger, Repts., 1880, p. 72; Lake Biwa.

Acheilognathus lanccolata Jordan and Snyder, Proc. U. S. Nat. Mus., XXIII, 1901, p. 344; Lake Biwa.—Jordan & Fowler, Proc. U. S. Nat. Mus., XXVI, 1903, p. 819; Tsuchiura, Chikugo River, Yodo River. Lake Biwa, Katata, Lake Yogo, Wakanoura, Owari, near Nagoya (not specimens from Funayado),

This species is here described from very numerous specimens, adult and young, from Lake Biwa, at Matsubara, in part the collection of Dr. Jordan in 1911, and in part specimens previously recorded from that locality by earlier authors and now in the collection of Stanford University. They are the originals of *Acheilognathus lanceolata* Jordan and Fowler.

Depth 3.33 in body-length to base of caudal; D. III, 9; A. II, 10; scales in lateral line 36 to 39, in transverse series between insertions of dorsal and anal 6/4, pharyngeal teeth 5–5.

Head 4 in body-length; eyes 3.57 in head; snout 4; mouth but slightly oblique; barbel long, somewhat more than half diameter of eye, coarse; gill-rakers 2+8; pharyngeal teeth hooked, smooth, and with narrow grinding surface; caudal peduncle short, 1.14 in head, its depth 2 in head.

Dorsal inserted nearly midway between snout and base of caudal, its base 1.125 in head, its height 1.33; anal inserted under fifth or sixth branched dorsal ray, its base 1.33 in head, its height 1.83; its margin straight; pectorals and ventrals equal, 1.5 in head, the ventrals inserted under first dorsal ray.

Color in alcohol plain, without lateral stripes or spots, except for an indistinct line along sides of caudal peduncle; dorsal in adult with a broad indistinct bar of blue-black along the middle of membrane; anal similar, but margined with white; pectorals clear; ventrals and belly from jaws to middle of anal nearly black in all the males; peritoneum black.

54. **Acheilognathus lanceolatus** (Temminck & Schlegel).

Capoeta lanceolata Schlegel, Fauna Japonica, 1846, p. 202, pl. C., fig. 5, near Nagasaki.

Matsubara, on Lake Biwa.

We give here a description of a female specimen 93 mm. in total length, with numerous others, male and female, between 56 and 75 mm. in body-length, from Funayado, Kiusiu, collected by Jordan and Snyder (No. 7359, Stanford University Collection):

Depth 3.33 in body-length to last vertebra; D. III, 8; A. II, 9; scales in lateral line 35, in transverse series between insertions of vertical fins 6/4; pharyngeal teeth 5–5.

Head about 4 in body length; eye 3.16 in head; snout slightly longer than diameter of eye; mouth but little oblique; anterior edge of premaxillaries level with lower edge of pupil; gill-rakers 2+8, slender and short; pharyngeal teeth smooth, hooked, with narrow grinding surface, and uncolored; barbel long, equal to snout; lateral line complete; caudal peduncle short, 1.14 in head, measured from last anal ray, its depth moderate, 2 in head; breadth of body, 2 in head.

Dorsal insertion midway between snout and base of caudal, its base 1.33 in head, its height 1.5; anal inserted under last dorsal ray. Its base 1.5 in head, its height the same, its margin straight; ventral 1.83 in head, inserted under first dorsal ray; pectoral equal to length of base of dorsal.

Color in alcohol plain, save for faint trace of black in a line along sides of caudal;

dorsal surface of head and line of back dark; belly in males coarsely pigmented, with colored area sharply limited above, extending over ventral surface of head and along base of anal; dorsal with black along middle of membrane, but with the rays uncolored, and pattern frequently obscured by a general heavy pigmentation; anal narrowly margined with black, otherwise as dorsal; ventrals black, pectorals and caudal dusky; in many cases fins entirely colorless; peritoneum silvery with black reticulations.

This species may be distinguished from others by the absence of strongly marked lateral bands, the long barbels, the number of fin-rays, smooth pharyngeal teeth, proportions of the fin-bases and the measurements of the caudal peduncle. The specimens described were recorded as *Acheilognathus lanceolata* by Jordan and Fowler. From this species it is differentiated by the possession of one less divided ray in both the dorsal and anal fins, by the longer barbel, and by the greater average depth of the caudal peduncle.

55. **Acheilognathus moriokæ** sp. nov. (Plate XXV, fig. 2).

Acheilognathus limbata Jordan & Fowler, Proc. U. S. N. Mus., XXVI, 1903, p. 818, in part. Specimens from Morioka, on the Kitakama River, and some specimens from Lake Biwa, at Matsubara.

Among the specimens recorded from Morioka by Jordan and Fowler as *Acheilognathus limbata* is a species which appears to be new. The type is in the collection of Stanford University. Cotypes are in the Carnegie Museum.

Description of the type, 95 mm. in total length and 75 mm. in length to base of the caudal.

Head 4 in body-length; depth of body 2.86; D. III, 9; A. II, 8; thirty-seven scales in lateral line, in transverse series between vertical fins 6/5; pharyngeal teeth 5–5.

Tip of premaxillaries at level of, or slightly below, lower edge of pupil; snout slightly overhanging premaxillaries; mouth not very oblique; gill-rakers 2+12, of equal length throughout; pharyngeal teeth smooth, with a narrow grinding surface and hooked tip; lateral line complete; barbel a quarter of diameter of eye in length, or less, somewhat coarse in texture; depth of caudal peduncle 2 in length of head, its length 1.14 in same, or 4.5 in body-length.

Dorsal inserted midway between tip of snout and base of caudal; its base 1.25 in head; its length 1.5; anal inserted under last dorsal ray, its base 1.7 in head, its height the same, first branched ray extending beyond base of last; margin of fin somewhat falcate; ventrals under dorsal insertion, their length equal to anal height; that of pectorals slightly greater.

A blue-black lateral stripe along sides of caudal, its width over half as wide as

eye, tapering to a point under first dorsal rays and shortly before base of caudal; shoulder-spot very indistinct, diffuse, extending posteriorly over five or six scales. Dorsal slightly margined with black, three narrow white stripes alternating with dark ones on median part of fin; anal nearly colorless, with traces of white stripes on middle of rays; other fins colorless. In a cotype the ventral and anal fins are dusky, but with a clear edge.

Of this species we also have a number of specimens from Lake Biwa, resembling the type in every respect. It is distinguished from other species by the number of the fin-rays, short dorsal base, broad lateral stripe, indistinct shoulder-spot, and short barbel. From *Acheilognathus tabira* it is distinguished by a less oblique mouth, serrated pharyngeal teeth, smaller eye, less depth, more falcate anal, the first developed ray extending always beyond the insertion of the last, and one less ray in both the dorsal and the anal. In none of our specimens is the shoulder-spot so distinct as in *Acheilognathus tabira*.

A specimen from Funayado, Kiusiu, collected by Jordan and Snyder, is a female differing from this species by one less ray in the anal, a very short barbel, and shorter fin-bases. The lateral line is complete, the pharyngeal teeth smooth, with a very narrow grinding surface.

KEY TO JAPANESE SPECIES OF *Acheilognathus*.

a. Pharyngeal teeth in part at least plicate transversely on the lower lateral face of each tooth (not verified in *A. brevianalis*); barbels small or obsolete.

b. *Paracheilognathus* Bleeker; barbels small.

c. Dorsal fin very long, of fourteen or fifteen developed rays; shoulder-spot present, close behind opercle; depth 2.25 in length; anal rays nine or ten; dorsal base 3.5 in body; teeth all plicate..... *rhombeus*.

cc. Dorsal fin short, of eight to ten developed rays.

d. Shoulder-spot close behind opercle; depth 2.75 in length; base of dorsal short; teeth not all plicate, scales thirty-seven; dorsal rays nine or ten; anal rays nine or ten.. *tabira*.

dd. Shoulder-spot five or six scales behind opercle; dorsal base very short, 5 in length; scales thirty-nine..... *cyanostigma*.

bb. *Rhodeops* Fowler, barbel wanting.

c. Dorsal with fifteen developed rays; opercular spot wanting; anal rays fourteen or fifteen; depth 2.125 in length..... *longipinnis*.

cc. Dorsal with ten developed rays; anal with ten; depth 2.5; scales thirty-three; no shoulder-spot; teeth undescribed..... *smithi*.

ccc. Dorsal with eight developed rays, anal rays seven, depth 3.2 in length; scales thirty-seven; no shoulder-spot; teeth little plicate (?)..... *brevianalis*.

aa. *Acheilognathus;* pharyngeal teeth all smooth; barbel present, short or long; dorsal short, of about eight rays.

g. Depth great, 2.33 to 2.125 in body-length; no lateral stripe; barbels long, over half diameter of eye, and equal to snout; D. III, 8; A. II, 10 or 11..... *limbatus*.

gg. Depth less, 3.33 to 2.77.

h. Barbels slightly over half diameter of eye; lateral stripe indistinct, or lacking.

i. D. with nine developed rays; A. 10; barbel 1.5 in snout ..... *intermedius.*

ii. D. 8; A. 9; barbel equal to snout ..... *lanceolatus.*

hh. Barbels much less than half of eye; lateral stripe indistinct, as wide as pupil of eye... *moriokæ.*

Note on *Metzia* Jordan & Thompson, a New Genus of *Cyprinidæ*, Allied to *Acheilognathus.*

The species described by Jordan and Evermann (Proc. U. S. N. Mus., Vol. XXV, 1902, p. 323), as *Acheilognathus mesembrinus*, may be taken as the type of a new genus, *Metzia*, characterized by three rows of pharyngeal teeth 1–3–5 on left side, 1–3–4 on right; lateral line complete, decurved; anal inserted behind last dorsal ray; maxillary long, extending beyond anterior border of eye; body deep, compressed; peritoneum black; intestine elongate; no barbel. Characters otherwise as in *Acheilognathus.* Named for Charles William Metz, assistant in Stanford University, and associated with the writers in the identification of the fishes of the collection upon which we are now reporting.

56. **Acanthorhodeus atremius** sp. nov. (Plate XXV, fig. 3).

The genus *Acanthorhodeus* Bleeker is separated from *Rhodeus* by the development of one of the rudimentary rays of the dorsal as a distinct spine. The Chinese species of the genus are large fishes, sharply separable from *Rhodeus,* but the Japanese species of *Acanthorhodeus* are scarcely distinct from the other genus. This may make the mergence of the two groups necessary.

Described from two specimens collected by Jordan & Snyder in the Chikugo River at Kurume in 1900; both males,4.5 and 5 cm. in total length; type in the Stanford University Collection: cotype in the Carnegie Museum.

Head 4 in body-length; depth 2.4; eye 2.66 in head; snout 4; length of caudal peduncle from last anal rays 1.25 in head, its depth 2; dorsal height 1.25; dorsal base 1.125; anal height 1.5, its base 1.2; D. rays II, 10; A. II, 9 or 10; pharyngeal teeth 5–5; scales in lateral series, 32, in transverse series between insertions of vertical fins 11, between occiput and dorsal 16.

Snout not overhanging premaxillaries, its tip level with lower half of pupil; maxillaries not quite reaching anterior border of orbit; mouth not very oblique; male with tubercular prominences on snout widely separated and protuberant; a small tuberculated area above and between eye and nostril; no barbels present; pharyngeal teeth hooked, with narrow grinding surface occasionally plicate on the lower side as in *Acheilognathus rhombeus;* gill-rakers short, 3+6.

Dorsal inserted midway between snout and base of caudal, its third, or first

branched ray extending beyond base of last; second ray somewhat spine-like and strong, its length two-thirds that of succeeding ray; first spine three-fifths of length of second; outline of fin straight, last ray nearly as long as third; anal similar, save that its spine is three-quarters of the length of the succeeding ray; its insertion under fourth branched ray of dorsal; its third ray, when supine, extending beyond base of its last ray; pectorals reaching beyond base of ventrals, their length 1.2 in head; ventrals reaching insertion of anal, length slightly less than that of pectorals.

Lateral line continued horizontally, only through first four scales, its lateral series of scales then dropping sharply towards ventral line of body.

Color-pattern that of *Acheilognathus*, a lateral blue-black stripe, widest posteriorly where it nearly equals diameter of pupil, and ending abruptly; anteriorly the stripe narrows, vanishing two or three scales in front of dorsal; an indefinite shoulder-spot just behind angle of gill-opening, succeeded by a silvery area two scales wide, another indefinite spot behind this, the whole slightly larger than eye; line of back very dark; belly pigmented, as is usual in males of this group; dorsal anteriorly margined with white, posteriorly tipped with black; remainder of fin dusky, with two faint narrow longitudinal stripes about the middle; anal similar, but with white margin continued posteriorly proximal to black tips of rays; stripes on fin very indistinct, pectorals and ventrals without pattern, latter dark, as is the belly.

This species may be easily distinguished by the broad lateral band of blue-black and the white margined anal, besides by the depth and the pharyngeal teeth.

57. **Acanthorhodeus sciosemus** sp. nov. (Plate XXVI, fig. 1).

Described from six females and three males, the longest 4 cm. in total length, from Chikugo, collected by Jordan and Snyder in 1900. The type is in the Stanford University Collection.

Head 3.75 in body-length; depth 2.5; eye 2.75 in head; snout 4.25; length of caudal peduncle from last anal rays 1.4 in head, its depth 2; dorsal height 1.33; anal height 1.4. Dorsal rays II, 10; anal rays II, 9 or 10; scales in lateral series 32, in transverse series, between insertions of vertical fins, 11; pharyngeal teeth 5–5.

Snout not overhanging premaxillaries, its tip level with center of eye; maxillaries extending to below anterior margin of eye; no barbel present; mouth but slightly oblique; tuberculated areas on snout of males not prominent in any specimens examined, nor are patches present before eyes; pharyngeal teeth hooked, with narrow grinding surface, without serrations or plicate sides; gill-rakers short, 2+4.

Dorsal inserted nearer base of caudal than tip of snout by length of latter; first branched ray extending beyond base of last, when supine; second ray spine-like with flexible tip, as long as succeeding ray; first spine half length of second; last ray

three-fifths length of third; outline of fin straight; anal similar in all respects, its insertion under fourth branched ray of dorsal; first branched ray barely reaching base of last one; pectorals 1.33 in head, just reaching base of ventral, latter four-fifths length of pectorals, and not reaching insertion of anal.

Lateral line present in first four scales, series continuing, dropping sharply from fourth towards ventral line of body.

A blue-black lateral stripe, half as wide as pupil, beginning three or four scales from last scales on caudal base and continued to within eight scales of angle of gill-opening, broadest part above anal base; shoulder-spot behind angle of gill-opening present in males only, represented in females by an occasional dusky area; in males very definite, square, as large as pupil, followed by a similar silvery area and a subsequent dark blotch; line of back darkest just before dorsals; belly in males pigmented as usual; dorsal with a prominent, definite blue-black spot somewhat triangular, its tip at base of fifth branched ray, its base as wide as pupil and half-way up second spiny ray; this spot being apparently the anterior portion of a broad stripe which is posteriorly indistinct; distally to this the fin is white having distad a narrower dusky band parallel to margin of fin; other fins without visible pattern.

The males of this species are apparently slenderer than the females with a depth slightly more than two and one-half times in the body-length; the anal narrowly edged with black; a broader and more vivid lateral stripe and shoulder-spots. The belly is pigmented as usual. In one specimen the spot on the dorsal is lacking.

KEY TO JAPANESE SPECIES OF *Acanthorhodeus*.

a. Lateral band broad as pupil, not pointed posteriorly; lateral line completely absent; no large spot on dorsal..... *atremius*.

aa. Lateral band very narrow, less than half width of pupil; lateral line present in first four scales; a large black spot anteriorly on dorsal..... *sciosemus*.

58. **Rhodeus kurumeus** sp. nov. (Plate XXVI, fig. 2).

Described from numerous specimens collected in the Chikugo River at Kurume in Kiusiu by Jordan and Snyder in 1900, the longest female 5 cm. in total length, the longest male 5.3 cm., both breeding, the females frequently with eggs partly extruded through the ovipositor. A male in the Stanford collection is taken as the type; No. 6011a Carnegie Museum is the cotype.

Head 3.83 in body-length; depth 2.75; snout 4 in head; eye 3.2; length of caudal pedunele from last anal rays 1.5 in head, its depth 2.125; dorsal height 1.4; dorsal base 3.4 in body-length; anal height 1.33 in head; its base nearly equal to head; dorsal rays II, 10 (or 11); anal rays II, 10 (or 11); pharyngeal teeth 5–5; scales in lateral series 33 (32–35), in transverse series, 11, between occiput and fifteenth dorsal.

Tip of snout level with center of eye; maxillary ending below nostril and before eye; mouth but slightly oblique; male with tubercular prominences close together on front of snout; a number of horny buds ranged along upper anterior rim of orbit, and numerous others over dorsal surface of head in full breeding male; no barbels present; gill-rakers (in cotypes of same size) 3+10; pharyngeal teeth smooth, some hooked, others simple, sickle-shaped, grinding surface narrow, in some an indication of transverse striation.

Dorsal inserted midway between tip of snout and base of caudal, its first branched ray not reaching base of last, when supine; second ray flexible and pointed at tip, not spine-like, equal to length of succeeding ray; last ray more than three-fourths the length of the second; anal similar, its last ray two-thirds the length of third, its margin straight, not falcate nor emarginate; its insertion under third branched ray of dorsal, tips of last dorsal and anal rays opposite, when supine; pectorals not reaching bases of ventrals; latter barely reaching anal insertion; caudal longer than head. Lateral line lacking, scales in corresponding series in no way modified. Dorsal line of body very dark between occiput and insertion of dorsal; lateral blue-black band rather faint, pointed acutely at both ends, one-fourth as wide as pupil, beginning under fifth or sixth dorsal ray and continued to within four scales of base of caudal; shoulder-spot behind angle of gill-opening indefinite, though present, succeeded by a similar silvery area and another indefinite blotch, the whole larger than eye; dorsal dusky, with two rows of white spots on rays, the proximal row half-way up fin; no large spot present; anal similar, but much less distinctly colored, narrowly edged with black; ventrals dusky (breeding male); pectorals and caudal clear; ventral surface of belly pigmented.

The females of this species seem to be slenderer, depth 2.5 in length; without dark ventrals; anal with black margin; belly pigmented and with a fainter lateral stripe and color-pattern on fins less plainly shown.

A male specimen from Nagoya, resembling this species, has thirteen dorsal rays and fourteen rays in the anal, with a lesser depth of body. Having but the single specimen, we hesitate to regard it as a distinct species. The fins are plain dusky, the lateral stripe as in the other specimens; the lateral line entirely lacking. Two from Lake Biwa have a like number of fin-rays, and have a black spot anteriorly on the dorsal. As the normal number of anal rays in *Rhodeus kurumeus* is but twelve, it is probable that these specimens represent at least one other species.

59. **Tanakia oryzæ** (Jordan & Seale) gen. nov.

An examination of the type of *Rhodeus oryzæ*, at present in the collection of Stanford University, shows the lateral line to be apparently lacking posteriorly,

although the scales are modified throughout in a continuous series. The tip of each scale is emarginate and a groove lies along the center of the scale where the tube should lie. This species, with *Rhodeus miobuta* Tanaka, has barbels as in *Acheilognathus*. *Rhodeus oryzæ* may be taken as the type of a new genus *Tanakia*, separated from *Rhodeus* by the presence of a barbel. It is named for Shigeho Tanaka, the accomplished ichthyologist of the Imperial University of Tokyo.

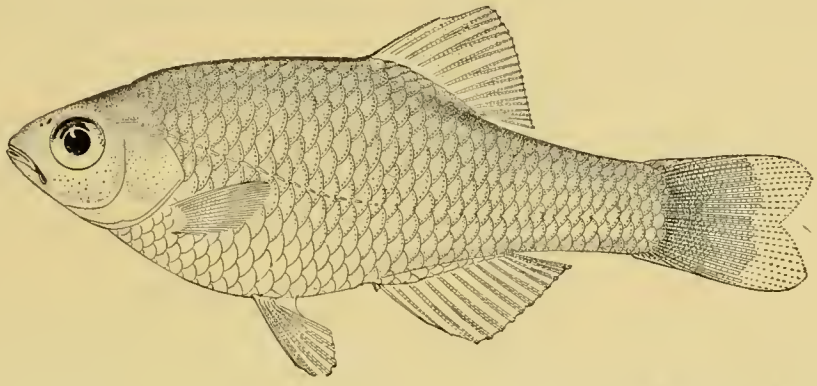


FIG. 6. *Tanakia oryzæ* (Jordan & Seale). (From Proc. U. S. N. M., Vol. XXX, p. 144).

Body deep, compressed; mouth small, maxillary not reaching eye; a short barbel at its tip; dorsal and anal of about twelve rays, the first two unbranched; pharyngeal teeth 5–5, smooth, hooked at tip; gill-rakers very short; lateral line incomplete, but marked posteriorly by modifications of a series of lateral scales; peritoneum black; intestine elongate. Fresh-water fishes of small size, about two or three inches in length.

60. **Pseudaspius atrilatus** sp. nov. (Plate XXVI, fig. 3).

Lake Biwa at Matsubara, No. 6012a.

D. III, 7; A. III, 7; P. 16; V. 8; scales in lateral line 82 (79 to 83), in oblique transverse series between dorsal and anal insertions, 22/12, between occiput and dorsal, 59 (52–59); pharyngeal teeth 4, 2 on left, 2, 4 on right; gill-rakers 1+5 (1 or 2+4 to 7).

Head 4 in length to base of caudal; width of head 1.9 in its length; depth of body 5 in its length; eye 5 in head; snout 3.66; interorbital space 3.375; maxillary 3.375; caudal peduncle, depth 2.25, length 1.125; first dorsal ray, length 1.4; base 2.5; first anal ray, length 1.66, its base 2.5; pectoral 1.5; ventral 1.8.

Body elongate, not greatly compressed, snout slightly projecting; lower jaw included; upper profile of head straight from nostrils to occiput; posterior margin of eye midway between snout and edge of opercle; maxillary not reaching eye; pharyngeal teeth hooked, with very narrow grinding surface or none; gill-rakers small, widely set; intestine short, one convolution; peritoneum dark.

Dorsal very slightly nearer base of caudal than tip of snout, its margin straight; anal inserted under last dorsal ray; pectorals extending over half-way to ventrals; latter reaching vent, not anal. Caudal forked.

Scales small, especially on occiput and breast, lateral line slightly decurved, continuous.

Color dark above, with fine irregular stippling; a darker band arising on snout and terminating with slight dilation at base of caudal, which has a basal spot in young; breadth of band equal to diameter of eye. A dark median band from occiput to caudal. Upper fins slightly dusky, lower clear.

We have five specimens, 62 to 87 mm. in total length, all from Lake Biwa.

The species may be readily separated from Japanese species of *Leuciscus* by the insertion of the anal fin, which lies under the last ray of the dorsal, and by the small scales.

In form and coloration this species resembles the American genus *Rhinichthys*. In the form of the head it differs considerably from the type of *Pseudaspius*, resembling more the species of *Leuciscus*. It may be generically different from *Pseudaspius*. It has an ally in Korea, which we have also referred to *Pseudaspius*,

61. **Zacco platypus** (Temminck & Schlegel).

Lake Biwa at Matsubara, No. 6219 many, Okayama No. 6013a.

A young male much slenderer than the others and the color more vivid. Females with lower fins.

62. **Zacco temmincki** (Temminck & Schlegel).

Okayama, No. 6081a.

63. **Zacco sieboldi** (Temminck & Schlegel).

(*Zacco mitsukurii* Tanaka.)

Lake Biwa at Matsubara, Nos. 6210a–h; Sendai; Nagoya, No. 6449a.

Teeth 1, 4, 5–4, 4, 1. Scales 62.

64. **Opsariichthys uncirostris** (Temminck & Schlegel).

Lake Biwa, at Matsubara, No. 6278 many.

This abundant chub is an excellent food-fish and deserves introduction into the lakes of America.

65. **Pseudorasbora parva** (Temminck & Schlegel).

Yodo River, Osaka, No. 6283, many; Lake Biwa, at Matsubara.

66. **Leuciscus hakuensis** Günther.

Two specimens, No. 6331a–b, from Lake Biwa at Matsubara, differ from all others in the lower fins and slightly shorter maxillary. One from Hakodate, No. 6195a, has scales 75; another from Sendai, No. 6245a, has scales 16–79–13. This

may correspond to *Leuciscus taczanowskii* as described by Jordan and Fowler, no distinction appearing. This very widely distributed and abundant species shows slight differences in various localities, some of them perhaps being permanent distinctions.

67. **Ishikauia steenackeri** (Sauvage). (Plate XL, fig. 2).

Lake Biwa at Matsubara, No. 6321 many; Yodo River, at Osaka, Nos. 6271a–b, Teeth 2, 4, 5–4, 4, 2. Scales 65.

Family ANGUILLIDÆ.

68. **Anguilla japonica** Temminck & Schlegel.

Misaki, Nos. 6249a–d; Okayama, No. 6336a.

Family SIMENCHELYIDÆ.

69. **Simenchelys leptosomus** Tanaka.

Izu (Owston Collection).

A large specimen eighteen inches long, much larger than the types. The pectoral is much larger, the eye smaller. The body is 1.33 not 1.66 times in the tail.

Family LEPTOCEPHALIDÆ.

70. **Leptocephalus myriaster** (Brevoort).

Osaka, Nos. 6324a–b.

71. **Leptocephalus nystromi** Jordan & Snyder.

Misaki, No. 6105a; Osaka, No. 6090a.

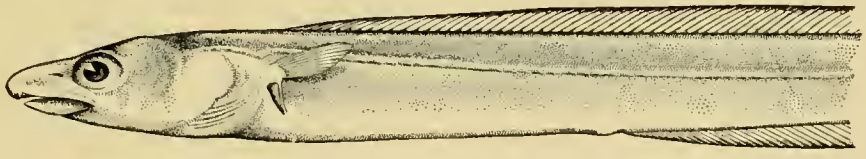


FIG. 7. *Leptocephalus nystromi* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIII, p. 853).

This may be *L. heterognathus* of Bleeker, but again that nominal species may be the young of *L. japonicus*, which may in turn be the young of *L. erebennus*.

72. **Leptocephalus riukiuanus** Jordan & Snyder.

One large example, No. 6288a, 61 cm. long. Head 1.875 in trunk; head and trunk 2 in tail; maxillary 2.5 in head; lower jaw slightly shorter; snout 4; eye 7;

FIG. 8. *Leptocephalus riukiuanus* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIII, p. 852).

dorsal inserted over middle of pectoral; thirty-six pores before vent. Pectorals black with lower margin white.

Compared with the original type of *L. riukiuanus*, this specimen seems to be the same.

73. **Leptocephalus erebennus** Jordan & Snyder.

Misaki, Nos. 6286a–b.

Fig. 9. *Leptocephalus erebennus* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIII, p. 850).

The two specimens agree with the type, which according to Franz is the same as *L. japonicus*.

74. **Leptocephalus anago** (Temminck & Schlegel).

Shimonoseki.

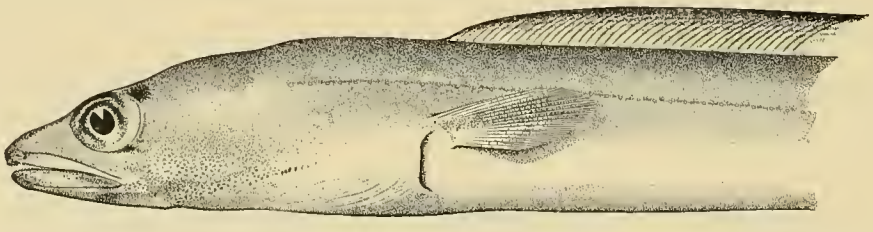


Fig. 10. *Leptocephalus anago* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXIII, p. 856).

75. **Leptocephalus megastomus** (Günther).

Misaki, No. 6433a.

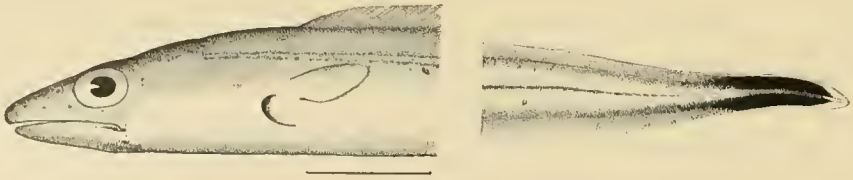


Fig. 11. *Leptococephalus megastomus* (Günther). (From Proc. U. S. N. M., Vol. XXIII, p. 855).

It has the maxillary shorter than in the figure of Jordan & Snyder and the snout is somewhat shorter. The species is mid-way between *Leptocephalus* and *Congrellus*, requiring apparently the union of the two groups.

Family MYRIDÆ.

76. **Myrus uropterus** Temminck & Schlegel. No. 6460 (Plate XXVII, fig. 7).

We here figure a larval eel from Misaki, which we refer, very doubtfully, to this species. We can identify it with no other from Japan.

Family MURÆNESOCIDÆ.

77. **Murænesox cinereus** Forskål.

Osaki, Nos. 6385a–b, Shimonoseki.

Family NEMICHTHYIDÆ.

78. **Nemichthys scolopaceus** Richardson.

Misaki, No. 6025a.

Two specimens sixty-nine and ninety-three centimeters long, from Sagami Bay. No tangible distinction from Atlantic specimens is apparent, except that the head is noticeably larger. It is is recorded from Papua, and by Franz from Sagami Bay.

Family OPHICHTHYIDÆ.

79. **Ophichthys asakusæ** Jordan & Snyder.

Kobe, No. 6216a, C. M. Cat. of Fishes (Coll. Manabe). Hitherto known only from a specimen from Misaki in the Aquarium of Asakusa in Tokyo.

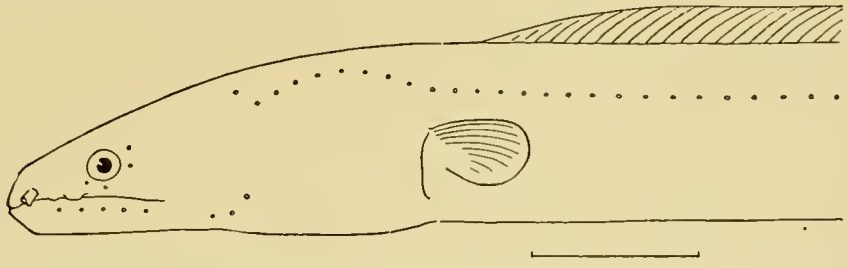


Fig. 12. *Ophichthys asakusæ* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIII, p. 873).

Family SOLENOSTOMIDÆ.

80. **Solenostomus pægnius** sp. nov.

Described from the type from Misaki, C. M. Cat. of Fishes, No. 6020, a male specimen 101 mm. in total length, badly shrunken from immersion in strong alcohol.

Head 2.2 in body-length without caudal; depth at base of ventrals 4.23; snout 3.33 in body; eye 6 in snout; maxillary 5 in snout; depth of snout 3 in its length, or 4.5 in head; length of caudal peduncle from last anal ray to middle caudal rays 4.7 in head; dorsal rays V. 20; A. 19; P. 25; V. 8.

Body-depth slightly greater than in known species, despite shrunken body; snout very deep, its depth equal to postorbital portion of head; the dorsal ridge, or edge of snout, arched in profile, beginning a diameter of eye before the anterior

edge of orbit, and ending shortly before the premaxillaries; lower edge of snout not as deep, but longer; siphonate part of snout noticeably deeper than the diameter of eye; upper edge of snout serrate anteriorly and posteriorly (contrasting with *S. cyanopterus*) (Pl. XLI, fig. 1), the supra-orbital ridges, which fuse to form dorsal edge of snout, likewise serrated; upper and posterior edges of orbit very coarsely and noticeably serrate, or roughened.

Distance from anterior border of eye to first dorsal spine greater than length of snout; height of dorsal spine 3.66 in body-length; tip of spinous dorsal extending to centre of base of second dorsal; distance between dorsal insertions 4.33 in body-length; height of second dorsal equal to diameter of eye; caudal peduncle from last anal ray to middle caudal rays short, 4.75 in head, length of caudal rays slightly greater than that of head; anal similar to soft dorsal; ventrals not adnate to belly, reaching middle of anal base.

Color somewhat similar to that of *S. cyanopterus;* body with small brown spots; pectorals with somewhat larger ones; caudal with numerous elongate, irregular, large spots, the biggest half diameter of eye in length; dorsal with two elongate black spots on membranes between first three rays at mid-height, remainder of fin spotted, as is caudal.

The measurements in hundredths of body-length of the type of *Solenostomus pœgnius* are as follows:—Head, .45; snout, .30; eye, .05; maxillary, .06; body-depth at base of ventrals, .22; length of caudal peduncle from last anal to middle caudal rays, .095; depth of snout at middle, .10; height of first dorsal, .26; of second, .05; length of ventral fin, .26; of caudal, .48; distance between tip of snout and first dorsal, .62; between eye and first dorsal, .28; between insertion of dorsal fins, .22. Those of *S. cyanopterus* (Bleeker), in so far as they differ, are: depth at ventral bases, .19; length of caudal peduncle, .08; depth of snout, .06; length of ventral, .33; of caudal, .34; distance eye to first dorsal, .25; between dorsal insertions, .26.

This species differs from the Japanese specimen of *Solenostomus cyanopterus* (Bleeker) cited by Jordan and Snyder in the much deeper snout; form of the dorsal edge of the snout; the serrated ridges of head; the shorter snout as compared to the distance from the first dorsal spine to the anterior border of the eye; longer caudal; slightly greater depth; and shorter ventral. It is probable that the depth of the snout is not a sexual mark, as the male described by Tanaka as *S. leptosomus* has the slenderest snout of any as yet described, save that of the female of *S. paradoxus.* (Plate XLI, fig. 2). Franz has recently declared the two latter species synonymous, comparing his own specimen from Dzushi. This is not impossible. The position of the dorsal bases, and their ray-length may be sexual marks, as they must be, if

the contention of Franz is true. The two nominal species, *S. leptosomus* and *S. paradoxus* vary widely in this regard, as well as in the length of the caudal peduncle The present species is sharply differentiated from these two forms by the very short caudal peduncle (a difference too great to be bridged by variation), and the much deeper snout, being in these regards most nearly related to *S. cyanopterus*. For purposes of illustration the figures of the latter and of *S. paradoxus* are given on Plate XLI, figs. 1 and 2.

81. **Syngnathus schlegeli** Kaup.
Yokohama, Nos. 6412a–b.

82. **Urocampus rikuzenius** Jordan and Snyder. (Plate XLI, fig. 3).
Misaki, Nos. 6083a–b. Rings 11+55 to 11+59.

Family AULORHYNCHIDÆ.

83. **Aulichthys japonicus** Brevoort.
Kobe, Nos. 6167a–c (Coll. Manabe); Misaki, No. 6410a.

Family FISTULARIIDÆ.

84. **Fistularia petimba** Lacépède.
Misaki, Nos. 6348a–g.

85. **Fistularia serrata** Cuvier.
Misaki, Nos. 6290a–e.

It corresponds to Günther's plate XXXII, in the "Shore Fishes of the Challenger."

Family MACRORHAMPHOSIDÆ.

86. **Macrorhamphosus sagifue** Jordan and Starks.
Misaki, Nos. 6185a–d.

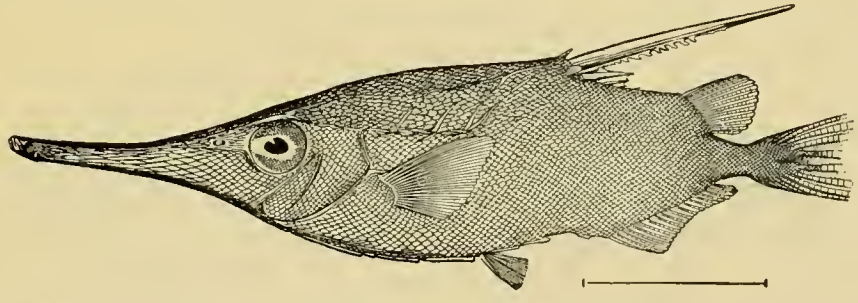


FIG. 13. *Macrorhamphosus sagifue* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVI, p. 69).

Depth variable, 3.5 to 4.5 in body. Possibly a variant of *M. japonicus* (Günther).

Family HEMIRAMPHIDÆ.

87. **Hyporhamphus sajori** (Temminck and Schlegel).
Kobe, Nos. 6442a–b (Coll. Manabe).

88. **Hemiramphus japonicus** Brevoort. (Plate XXVII, fig. 2).
Misaki, No. 6034a.

It agrees with the account given by Tanaka (Jour. Coll. Sci., Imp. Univ., Tokyo, XXIII, VII, 1908, p. 29) except that the eye is smaller, although Tanaka's specimen was larger than either of ours. Fins similar; air-bladder cellular, as in the type of *Hemiramphus*, the sides of body flattened and the ventrals posterior, nearly twice as far from the snout as from the base of the caudal. Head 4.5, with beak 2.4; mandible 3.5 in total length; D. 14, A. 12. Scales 53. Gill-rakers x+26.

This species, described by Brevoort from the Riu-kiu Islands, has only been lately recognized by Tanaka from Misaki.

Family ATHERINIDÆ.

89. **Iso flos-maris** Jordan and Starks.
Misaki, No. 6239 many.

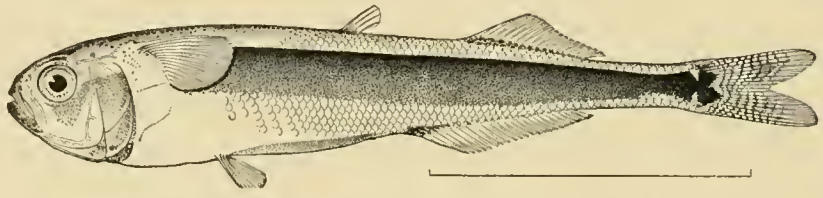


Fig. 14. *Iso flos-maris* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXIV, p. 205).

The genus *Tropidostus*, based on an Australian species, is identical with *Iso*, but this earlier name is preoccupied.

90. **Atherion elymus** Jordan and Starks.
Misaki, No. 6087 many.

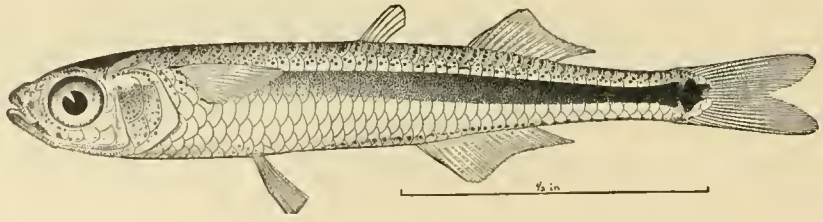


Fig. 15. *Atherion elymus* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXIV, p. 204).

91. **Atherina bleekeri** Günther.
Kobe, Nos. 6400a–b (Coll. Manabe); Osaka, Nos. 6088a–b.

92. **Atherina tsurugæ** Jordan and Starks.
Misaki, Nos. 6415a–f.

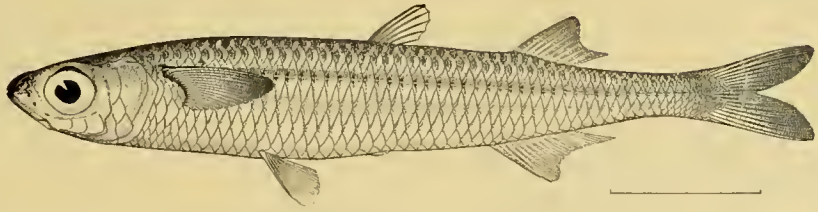


Fig. 16. *Atherina tsurugæ* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXIV, p. 202).

Family MUGILIDÆ.

93. **Mugil cephalus** Linnæus.
Matsushima Bay, Nos. 6293a–b; Osaka, No. 6259 many.

94. **Liza hæmatochila** (Temminck & Schlegel).
Misaki, Okayama, Nos. 6059a–j.

Family SPHYRÆNIDÆ.

95. **Sphyræna pinguis** Günther.
Misaki, Kobe, Yokohama, Osaka, Nos. 6304a–b.

Family BERYCIDÆ.

96. **Gephyroberyx japonicus** (Döderlein).
Misaki, No. 6340a.
D. VIII, 13; A. III, 11; P. I, 14; V. I, 6. Scales 30 (pores); abdominal scutes, 14.

Family HOLOCENTRIDÆ.

97. **Holocentrus spinosissimus** (Temminck & Schlegel).
Misaki, No. 6168a.

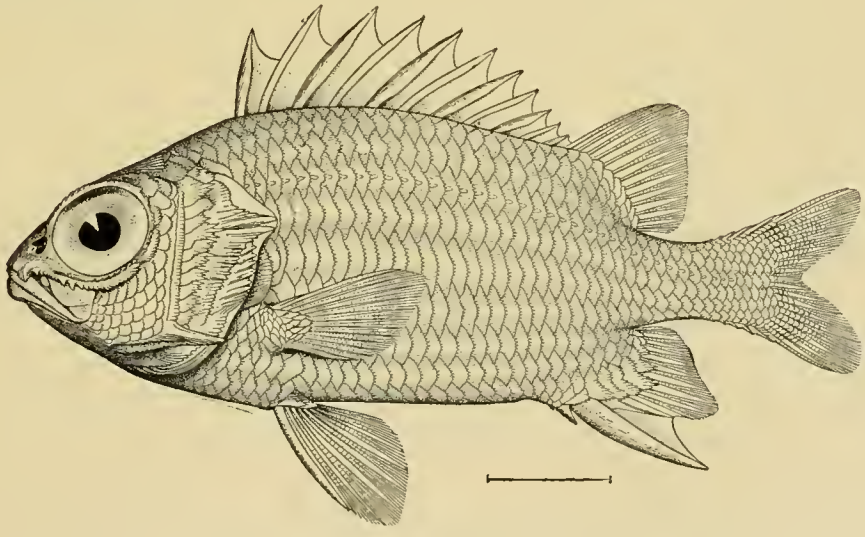


Fig. 17. *Holocentrus spinosissimus* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXVI, p. 14).

Young with a black spot between first and second dorsal spine. Body unmarked, except for faint pale streaks following the rows of scales.

Family SCOMBRIDÆ.

98. **Scomber japonicus** Houttuyn.
Osaka, Nos. 6388a–b.

99. **Auxis thazard** (Lacépède).
Osaka, Nos. 6294a–b; Sendai, No. 6392a.

Family TRICHIURIDÆ.

100. **Trichiurus japonicus** (Temminck & Schlegel).
Osaka, No. 6320a; Misaki, No. 6153a.

Family GEMPHYLIDÆ.

101. **Ruvettus pretiosus** Cocco.
Misaki, No. 6280a, a small example.

Family ISTIOPHORIDÆ.

102. **Istiophorus japonicus** Cuvier & Valenciennes.
Kobe (in collection of the Kwansei Gakuin).

103. **Tetrapturus mitsukurii** (Jordan & Snyder).
Abundant in Osaka Market.

Family CARANGIDÆ.

104. **Seriola purpurascens** (Temminck & Schlegel).
Osaka, No. 6292a; Sagami Bay, Nos. 6182a–b; Young specimens, the ventrals reaching slightly over halfway to soft anal. Depth 3.66 in total; head 4.

105. **Trachurus japonicus** (Temminck & Schlegel).
Kobe, Nos. 6177a–b.

106. **Decapterus russelli** (Rüppell).
Kobe, No. 6094a.

107. **Trachurops crumenophthalma** (Bloch).
Izu.

108. **Caranx equula** Temminck & Schlegel.
Osaka, No. 6367a; Shimonoseki, No. 6057a; Misaki.
Schlegel's plate of this species is correct as to depth of body notwithstanding the criticism of Steindachner.

109. **Alectis ciliaris** (Bloch).
Misaki, Nos. 6334a–c; Yokohama, No. 4195a.

Family EQUULIDÆ.

110. **Leiognathus rivulata** (Schlegel).
Misaki, No. 6109a.

111. **Leiognathus argentea** Lacépède.
(*Equula nuchalis*, Temminck & Schlegel).
Osaka, No. 6119a; Misaki, No. 6446a.

Family MENIDÆ.

112. **Mene maculata** (Bloch & Schneider).
Sagami Bay, Nos. 4101a–e (from Owston Collection).

Family STROMATEOIDIDÆ.

113. **Stromateoides candidus** (Cuvier & Valenciennes).
Osaka.

Family STROMATEIDÆ.

114. **Psenopsis anomala** (Temminck & Schlegel).
Osaka, No. 6238a; Shimonoseki, Nos. 6227a–c; Kobe.

115. **Labracoglossa argentiventris** Peters.
Misaki, No. 6438a, a common and pretty little fish. The relationship of the genus is still uncertain.

116. **Ectenias brunneus** gen. et sp. nov. (Plate XXVII, fig. 3).
Type No. 6453a; cotype No. 6454, Misaki. Sagami, No. 6006a.

This new genus, *Ectenias*, is allied to *Centrolophus*, being distinguished by its elongate, subterete form of body. There is one dorsal fin, the anterior spines merging into the soft rays; mouth moderate, jaws equal; teeth moderate, few-rowed, slightly enlarged anteriorly; palatines with small teeth; gill-rakers short; teeth in the œsophagus; scales minute; lateral line complete; dorsal with about fifty-eight rays, anal with twenty-five; ventrals well developed.

We give below a description of the type of the species, *Ectenias brunneus*, No. 6453a, C. M. Cat. of Fishes, a specimen from Misaki one hundred millimeters long. Others, cotypes from the same locality, are smaller.

Head 4 in body-length; depth 5.8; eye 3.125 in head; snout 3.5; maxillary 2.25; interorbital space 3.5; depth of caudal peduncle 5; D. 58; A. 25; P. 20; V. 1.5. Scales with about two hundred and fifty pores in lateral line.

Head at nape as deep as body, which tapers evenly to caudal peduncle; latter slender, slightly compressed; eye large; maxillary reaching vertical from center of eye; suborbital space less than breadth of maxillary at tip; interorbital space broad, its sides parallel, projecting over anterior edge of eye; nostrils subequal,

midway between tip of snout and eye, closely apposed, anteriorly with slight rim; jaws equal; teeth of moderate size in both jaws, in a single row posteriorly, two rows present anteriorly, the inner some distance behind the outer; vomer with two somewhat large teeth; palatines with single row of small teeth; those in jaws slightly enlarged in outer row, especially anteriorly; gill-rakers short and blunt, about eleven on lower limb of first arch.

Dorsal inserted above pre-opercular margin and extending to within half an eye-diameter from base of caudal, its longest rays half length of head, but slightly lower in any portion of fin; anal inserted midway between base of caudal and center of eye, its longest rays about as long as snout, its base extending as far posteriorly as dorsal; pectoral 1.66 in head; ventrals 1.33 in head, inserted under pectoral base; caudal deeply forked.

Scales minute, imbedded, not imbricate; lateral line anteriorly sharply arched, apex of curve angular.

Color in alcohol dark brown; dorsal, anal, and ventral fins darker, nearly black; pectorals colorless; anal dusky, save for tips of lobes, which are clear.

Although allied to *Centrolophus*, the color and texture of *Ectenias* shows it to be a shore-fish.

Family ICOSTEIDÆ.

117. **Icticus ischanus** gen. et. sp. nov. (Plate XXVII, fig. 4.)

Type No. 6036a, from Okinawa.

The new genus *Icticus* seems related to *Icichthys*.

Body oblong, compressed, the tissues soft; lateral line present; inner ventral ray adnate to belly on either side of groove, which begins at ventrals and ends at the anus; body scaled; scales cycloid, small; teeth in a single series in each jaw, some on vomer and palatines. Fine loose teeth on upper pharyngeals; six branchiostegals; gill-openings wide, the membranes free from isthmus; four gills, a slit behind the fourth; pseudobranchiæ large; air-bladder present, small; dorsal long, divided into two separate fins, free from caudal; ventrals below pectoral base; body oblong, compressed; the skeleton soft and flexible, the whole structure soft as in *Icosteus* and *Icichthys*.

The type of *Icticus ischanus*, described here, is a specimen two hundred and forty-five millimeters in total length, coming from Okinawa, Riu-kiu Islands, No. 6036a Carnegie Museum Cat. of Fishes.

Head 3.4 in length to base of caudal; depth 4.166; eye 4 in head; maxillary 3.33; snout 3; pectoral 1.75; ventral 2.5; D. XII-30; A. 30; P. 19; scales in lateral line 125 (approximate); ten scales between insertion of first dorsal and lateral line.

Body soft, with little firmness; dorsal and ventral contours evenly arched; body compressed, especially at bases of dorsal and anal; depth of caudal peduncle 4.5 in head, dilating posteriorly at base of rudimentary rays; head blunt, sides flat, as is dorsal surface; snout vertical in profile at tip; jaws equal, lower series of teeth included; maxillary short, not reaching eye, completely hidden by preorbital; teeth in lower jaw close-set, cardiform, somewhat arrow-shaped, with fine antrorse serrations on each edge; diminishing quickly in size at mandibular symphysis; the teeth in the upper jaw widely set and irregularly placed, lacking posteriorly; teeth on upper pharyngeals fine, slender, and not thickly set.

Dorsal composed of two fins, base of first 1.5 in head, of second 1.5 times length of head; outline of first somewhat rounded, of second parallel with fin-base; height of both dorsals equal to eye; caudal forked; middle rays half length of outer; anal similar to second dorsal and of equal height, its insertion under that of latter; pectoral extending to midway between vent and anal insertion; ventrals inserted under pectoral base, their inner rays separate and adnate to either side of a shallow groove extending back to anus.

Scales small, cycloid, present on cheeks, opercles, pectoral and caudal bases, and body, very deciduous; lateral line two-thirds of eye-diameter below dorsal base, with which it is parallel.

Color uniformly dark; fins black; peritoneum and lining of mouth-cavity black.

Family CARISTIIDÆ.

118. **Caristius macropus** (Bellotti). (Plate XXVIII, fig. 7).

(*Pteraclis macropus* Bellotti, Atti. Soc. Sci. Nat. Ital., Milan, 1903, p. 137. fig. VI, Yokohama).

Sagami Bay, No. 6024a (from Owston Collection).

This specimen represents a second species of the singular genus *Caristius*, obtained from the shores of Japan. It was originally made known by Cristoforo Bellotti in 1905, under the name of *Pteraclis macropus*.

The specimen before us, from the Kuro Shiwo off Sagami Bay is, however, plainly a member of the genus *Caristius*, and at the same time distinct from *Caristius japonicus*. The following description of this specimen was drawn up for Professor Edwin Chapin Starks.

Dorsal rays 34; anal 22; pectoral 18; ventral I, 5. Head 3 in length; depth of eye 2. Eye 2.33 in head; maxillary 1.66. Body and fins extremely fragile.

The form is much compressed, elevated to a rounded angle above eye, sharply declivous in front of eye, and sloping backward in a straight line (straighter than

in the drawing) to caudal peduncle. The body is covered with small, circular, cycloid, deciduous scales, a few only remaining near the middle of the body behind the pectoral. One was found below the pectoral in the region where they are enlarged in *Caristius japonicus*. It was not larger than the others. The cheek

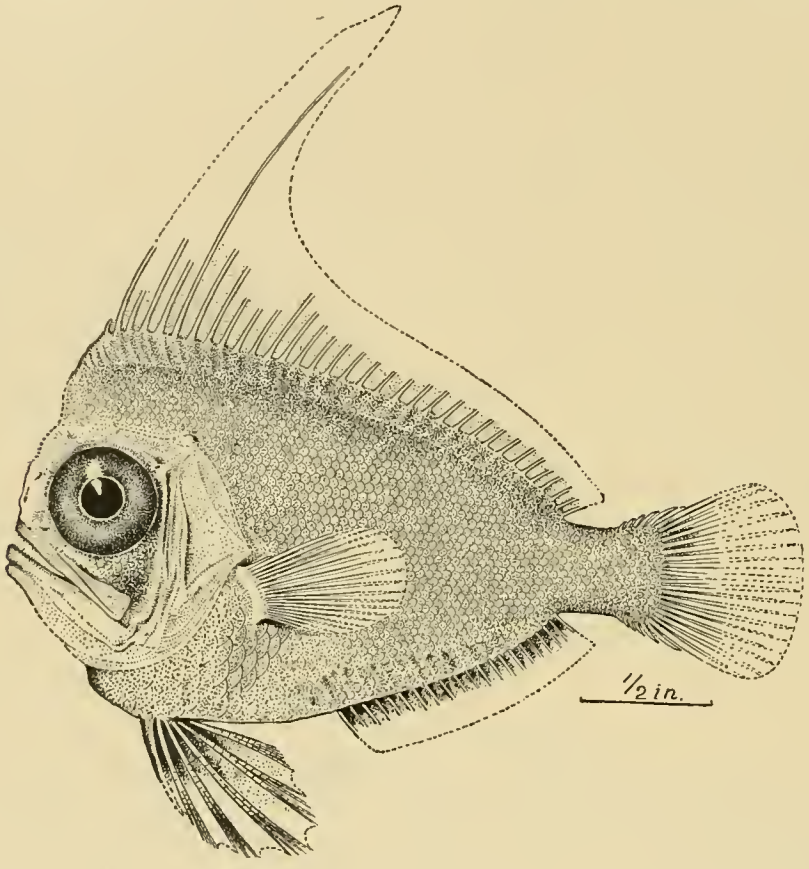


FIG. 18. *Caristius japonicus* Smith & Pope. (From Proc. U. S. N. M., Vol. XXXI, p. 491).

and opercle was fully scaled, the scales similar to those on the body, though few scales now remain. The lateral line is distinct and runs from the upper part of the opercle on a level with the upper margin of the pupil, straight back, with no curve whatever, to the middle of the caudal base. There was probably a sheath of scales along the base of the dorsal and anal, as in *Pteraclis*, but the scales are smaller and more deciduous than in this genus.

There are rather slender teeth in a straight row on the edges of both jaws and on the vomer and palatines. The cheek is deep and triangular, about four-fifths of the diameter of the eye in depth. The gill-rakers are rather slender, the longest about half the diameter of the pupil and they number 6+14.

The pectorals are a little shorter than head, reaching about to ninth anal ray.

The ventrals are very long, a little longer than the body without the head, and reaching base of caudal. Dorsal very high, beginning over the eye, the first two rays short, the third longest of all, nearly four times length of second, reaching middle of caudal, the posterior margin of the fin nearly straight, the rays gradually shortened to the last, which is about two-thirds head. Caudal short, shorter than head, apparently truncate, and beginning under middle of pectoral, its rays subequal, and not one-third as high as the dorsal. All the fin-rays extremely slender and fragile.

Little color remains. The body is light slate-blue; the dorsal, anal, and ventrals black, the caudal and pectorals colorless.

This species seems to differ from *Caristius japonicus* in being slenderer, in having the cheek deeper, the ventrals not nearly so far in front of the pectorals, the anterior scales not enlarged, the ventral rays longer and perhaps the dorsal and anal rays also. These fins are broken off in the type of *Caristius japonicus.*

The specimen, 5.5 inches long, was taken by Alan Owston in the Kuro Shiwo, or Black Current, off Misaki, Sagami Bay, in Japan. It is in the Carnegie Museum at Pittsburgh.

Since the publication of the excellent description and figure of Bellotti, the genus has been unnoticed, until the discovery by Dr. Hugh M. Smith of the related species which he called *Caristius japonicus.*

The type of this species (Proc. Biol. Soc. Washington, XVIII, 1905; p. 249), was described in 1905 by Gill and Smith from the island of Shikoku in Japan as the "type of a new family of jugular acanthopterygians." Smith and Pope, (Proc. U. S. Nat. Mus. XXXI., 1906; p. 490, fig. 10), in the following year published a figure of it. In December 1912, Dr. Jordan (American Naturalist, Dec., 1912, p. 148) referring to Dr. Shufeldt's work on the pteraclid fish *Pterycombus brama,* made this remark "the singular *Caristius,* lately described from Japan by Dr. Smith, is an ally of *Pterycombus* and belongs to the same family."

In the same month, Regan (Ann. Mag. Nat. Hist., Ser. 8, Vol. X., Dec., 1912, p. 637), expressed a belief that *Caristius japonicus* Gill and Smith, and *Platyberyx opalescens* Zugmayer (Res. Camp. Sci., Monaco, XXXV, 1911, p. 101, Pl. 5, fig. 5), were "probably congeric and perhaps not specifically distinct" and that they both were referable to the berycoid fishes. As Mr. Regan had no specimens of either of these forms it is not surprising that he should have regarded the two as related. *Caristius* and *Platyberyx* have no more in common than a superficial resemblance, and *Caristius* is certainly not related to the berycoid fishes. Its affinities seem obviously to be with the scombroid forms, especially with *Pteraclis,* the genus in which Bellotti placed it.

In our judgment, the *Caristiidæ* compose a family distinct from the *Pteraclidæ*, their nearest relatives, and from the *Bramidæ* to which both are allied. The apparent differences between *Caristius* and related genera may be thus indicated:

Family PTERACLIDÆ.

Dorsal very high, beginning on head, continuous, its rays all simple; anal similar, beginning far forward, almost as long as dorsal; ventrals jugular, small, inserted below the eye. Scales firm, lobate. Vertical fins with a basal sheath of scales.

Pteraclis Gronow (*velifera*).[2]

Centropholis Hilgendorf (*petersi*).

Dorsal with 10 to 13 graduated rays; ventral rays, 1, 5; anal very high, its first long ray reaching to end of base of fin.

Pterycombus Fries (*brama*).

As in *Pteraclis*, but the anal lower, the first long ray of anal reaching only to middle of fin.

Bentenia Jordan and Snyder (*æsticola*).

Essentially as in *Pteraclis*, but with the fifth dorsal and second anal ray much enlarged. Ventrals very short, under the eye.

Family CARISTIIDÆ.

Anal beginning near middle of body; ventrals jugular, but behind eye. Scales small, caducous.

Caristius Gill and Smith (*japonicus*).

Family BRAMIDÆ.

Characters included above.

The *Bramidæ* differ in the hard scales, and in the backward insertion of the dorsal which is low and behind the head. Anal moderate, inserted below middle of body.

Family VELIFERIDÆ.

The *Veliferidæ* (*Vilifer* Schlegel), (*hypselopterus*), have the fins much as in *Caristius*, but the mouth is wholly different, and the family has no relation to *Caristius* or to *Pteraclis*.

Family PEMPHERIDÆ.

119. **Pempheris japonicus** Döderlein.

Misaki, No. 6176a.

Family CHEILODIPTERIDÆ.

120. **Amia sialis**, sp. nov. (Plate XXVIII, fig. 2).

The following is a description of the type, No. 6021, C. M. Cat. of Fishes, a specimen 123 mm. in total length, coming from Suruga Bay, Japan.

Dorsal VII–I, 9; anal II, 8; scales in lateral line 25; in transverse series 10; head 2.6 in body-length to base of caudal; depth 2.4; eye 3.75 in head; depth of caudal peduncle 2.5 in head; gill-rakers 5+13.

Body deep, nearly equal in depth to length of head; maxillary reaching to below

[2] *Pteraclis ocellatus* Cuvier and Valenciennes, with but two graduated rays in the dorsal and the ventrals I, 3, if these characters are exact, belongs to a different genus. It is probably, however, a true *Pteraclis*.

middle of eye, 2 in head; lower jaw barely longer than upper; snout equal in length to eye; preopercle finely serrate on both limbs; no canines present.

Third and fourth dorsal spines subequal, half length of head; spine of soft dorsal 2.125 in head, its first two rays equal to post-orbital part of head. Anal inserted under second soft ray of dorsal, second spine 3 in head. Pectoral reaching nearly to anal, as do ventrals; caudal emarginate. Scales finely ctenoid, rather loose; lateral line as usual.

Color nearly uniform, pattern lacking, save for an indistinct, small caudal spot; ventrals and spinous dorsal dark, latter black at tip. All other fins somewhat dusky.

This species is apparently most closely related to *Amia nigra* (Döderlein) from which it differs in its longer spines, its soft dorsal and anal, longer pectorals, shorter maxillary, and lighter color of anal, ventral, and soft dorsal fins.

121. **Amia semilineata** (Temminck & Schlegel).

Kobe No. 6040; Shimonoseki, Nos. 6444a–h; Osaka, Misaki, Nos. 6221a–b.

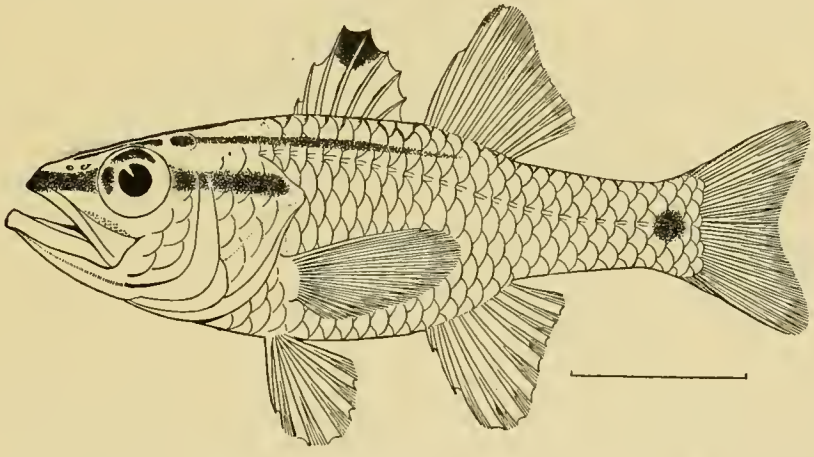


FIG. 19. *Amia semilineata* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXIII, p. 903).

122. **Amia kiensis** (Jordan & Snyder).

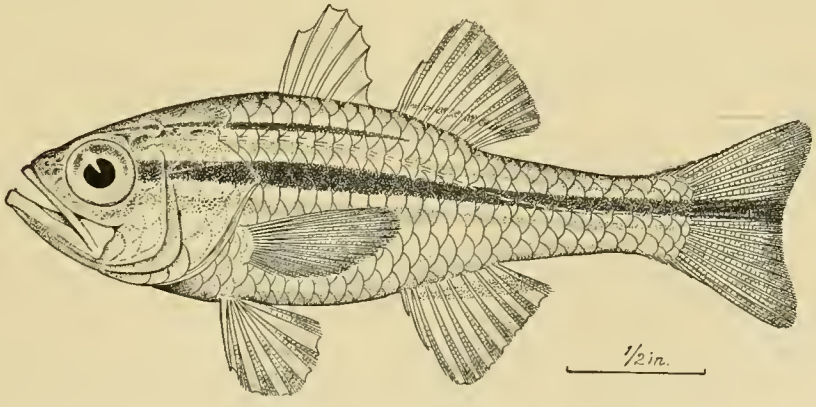


FIG. 20. *Amia kiensis* (Jordan & Snyder). (From Proc. U. S. N. M., Vol. XXIII, p. 906).

Misaki, No. 6051, tide-pools.

Young 3 cm. long, similar to adult in color, save lack of stripes on dorsal and anal.

Family KUHLIIDÆ.

123. **Safole Tæniura** (Cuvier & Valenciennes).

Misaki, No. 6091 many.

Abundant in the tide-pools. Color like that of the adult.

Family SERRANIDÆ.

124. **Lateolabrax japonicus** Cuvier & Valenciennes.

Shimonoseki, No. 7276a; Shinabara; Sendai.

125. **Niphon spinosus** Cuvier & Valenciennes.

Osaka; abundant in the market. Misaki, No. 6318a, tide-pools, young 6 cm. long.

A dark stripe from snout through eye to upper caudal rays, a fainter one below from lower caudal rays, and another as faint along dorsal profile of body from soft dorsal rays, where it is intense, separated narrowly from its fellow of the opposite side.

126. **Cephalopholis boninius** sp. nov. (Plate XXIX, fig. 7).

Description of type, No. 6038, a specimen 180 mm. in total length, from the Bonin Islands.

Head 2.6 in body-length to base of caudal, 3 in total depth; 3 in body; eye 5.75 in head; snout 3.66; maxillary 2; interorbital space 7.5; dorsal rays IX, 16; anal III, 9; scales in lateral series 108; in transverse series between insertion of dorsal and lateral line, 17; between lateral line and anal insertion 42; gill-rakers 7+11.

Maxillary extending to below posterior border of eye; latter small, 1.5 in snout; interorbital space narrow and slightly convex; teeth in upper jaw with enlarged outer row and minor band of minute teeth; a canine on each side anteriorly; a patch of enlarged depressible teeth behind each, most teeth posterior to these canine-like; similar and opposed patches in lower jaw, on sides and inner row of enlarged teeth, with several rows of much smaller teeth outside, all depressible save the outermost and smallest; vomer with a V-shaped patch of small depressible teeth; palatines with single row of similar ones. Gill-rakers stout and short, one half diameter of eye in length. Pre-opercular margin finely serrate on lower half of upper limb; opercle with three spines, middle longest.

Dorsal inserted over point of opercle; fourth to ninth spines subequal; 3.33 in head; first rays but slightly longer, longest (eleventh) 2.5 in head; anal inserted

under fourth dorsal ray, second spine longest and stoutest, 3 in head; longest ray 2.33 in head; tips of dorsal and anal rounded, reaching base of caudal; pectorals not quite reaching anal insertion 1.5 in head; ventrals reaching anus, 1.9 in head; caudal rounded. Scales small, ctenoid, absent on snout, jaws, and lower side of head, present on bases of vertical fins.

Body and vertical fins uniformly and evenly covered with brown spots (in alcohol) having a diameter one fourth that of eye arranged in irregular rows on fins and in part on body, separated by once or twice their own diameter. Two rows on spinous dorsal, four on dorsal and anal; pectoral with single spot on upper base; ventrals unspotted, narrowly tipped on outer rays with black; belly and breast unspotted, as is maxillary and chin.

127. **Epinephelus morrhua** (Cuvier & Valenciennes).

Misaki, No. 6055a.

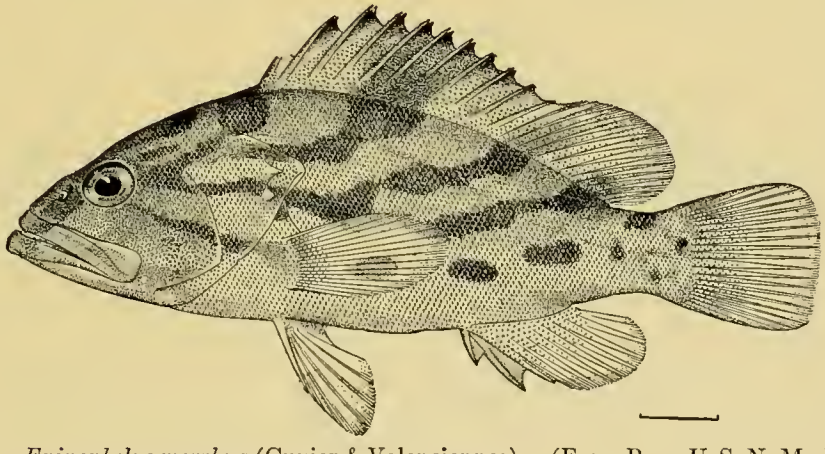


Fig. 21. *Epinephelus morrhua* (Cuvier & Valenciennes). (From Proc. U. S. N. M., Vol. XXXVII, p. 455).

Young with stripes as in the adult, but broader than the interspaces.

128. **Epinephelus megachir** Richardson. (Fig. 22).

A very small specimen, No. 6042a, doubtfully identified from a pool at Misaki. Second dorsal spine very elongate, 1.25 in head; ventral spines equally long. D. XI, 18; A. III, 8.

129. **Epinephelus akaara** (Temminck & Schlegel).

Osaka, Nos. 6353a–d; Misaki, tide-pools, No. 6047.

Young 32 mm. long. D. XI, 15; A. III, 8; scales about ninety-eight. Black in color everywhere, especially on fins, clear spots as large as pupil scattered regularly over body and fins. Caudal and anal narrowly margined with white. The identification of these young fishes is rather doubtful.

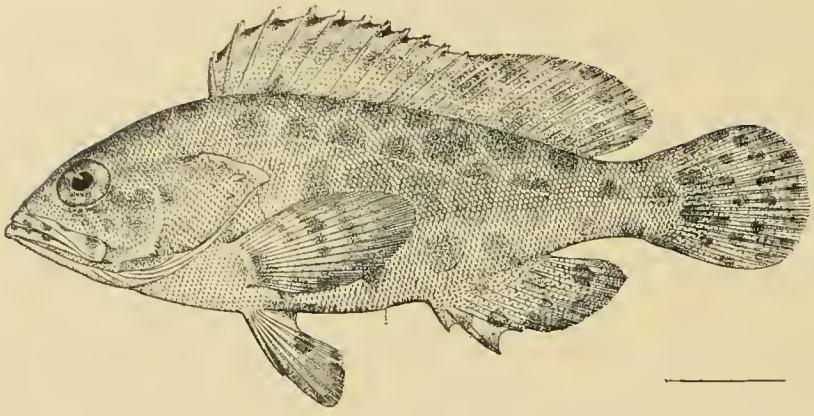


FIG. 22. *Epinephelus megachir* Richardson. (From Proc. U. S. N. M., Vol. XXXVII, p. 449).

130. **Epinephelus epistictus** (Temminck & Schlegel).

Kagoshima, No. 6172a.

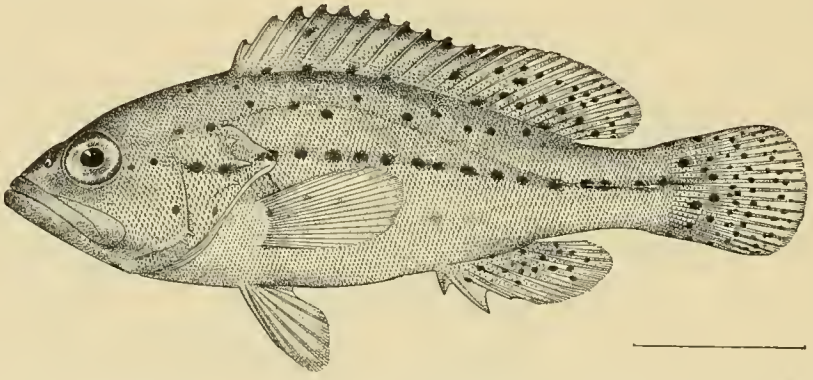


FIG. 23. *Epinephelus epistictus* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXXVII, p. 453).

131. **Epinephelus septemfasciatus** (Thunberg).

Enoshima, Nos. 6424a–b; Misaki, Nos. 6049a–d; Shimonoseki, No. 6267a; Osaka, Nos. 6354a–c.

One specimen has the coloration entirely plain, except for the black saddle on the caudal peduncle, and for the black moustache-streak.

132. **Chelidoperca hirundinacea** (Cuvier & Valenciennes).

Misaki, Nos. 6240a–b.

The smallest example has four dark lateral spots, or oblong blotches

133. **Aulacocephalus temmincki** Bleeker.

Misaki, No. 6381a.

Interorbital space strongly convex. Pale stripes not well defined anteriorly D. X, 11; A. III, 9.

134. **Franzia nobilis** (Franz) gen. nov. (Plate XXIX, fig. 2).

Misaki.

One specimen, No. 6452, agreeing with the description and figure of *Anthias nobilis* given by Dr. Franz. The maxillary, however, reaches to opposite the posterior border of the pupil. Head 3.5, as long as pectoral; depth 2.66; D. X, 17; A. III, 8; Scales 6–42–14.

This species differs from all the others hitherto referred to *Anthias* and *Pseudanthias* in having the spinous dorsal closely scaled. In other respects it is similar to *Pseudanthias* and *Dalanthias*. It has the third dorsal spine much elongate, the caudal lobes much produced, but not the ventrals. It should form the type of a distinct genus, which may be named for its discoverer, Dr. Victor Franz, the type being *Anthias nobilis* Franz.

135. **Franzia ardens** sp. nov. (Plate XXX, fig. 1).

Type No. 6457, a specimen ninety-three millimeters long to tips of middle caudal rays, from Misaki.

Head 3.5 in body-length without caudal; depth 2.66; eye 3.66 in head; interorbital space 3; maxillary 2.33; snout 4.33; third dorsal spine 2.14; last dorsal ray 2; second anal spine 2; last anal ray 1.5; pectoral 1.1; ventrals equal to head; D. X, 17; A. III, 7; forty-three scales in lateral line; scales in transverse series from insertions of ventral fins to lateral line 5/15; gill-rakers 10+21.

Maxillary extending to below center of eye; teeth in upper jaw in an enlarged outer row and a narrow band of minute inner teeth; a short canine tooth at either side of tip of upper jaw, and a larger pair immediately behind, which point backward and slightly medially; lower jaw with a single row of teeth on sides similar to outer row of upper jaw, then forming a narrow band of minute teeth anteriorly, which is narrowly interrupted at the mandibular symphyses; a short pair of canines pointing forward at tip of lower jaw, and a larger pair on either side at some distance behind; inner rows not enlarged anteriorly; pre-opercle serrate, rounded; opercle and interopercle somewhat serrate, opposite pre-opercular angle; opercle with two spines; gill-rakers two-thirds of eye.

Dorsal spines nowhere elongate, outline of fin rounded, third spine longest; tip of last dorsal rays pointed, extending nearly to caudal base; soft anal sharply angular posteriorly, its last rays slightly produced, reaching slightly beyond last dorsal rays to base of caudal; second anal spine slightly longer than third, 2.125 in head; ventrals extending to anus, not filamentous, second ray but slightly longer than first; pectorals rounded at tip, not reaching anus; caudal lobes produced; basal third of spinous and soft dorsal, and of soft anal, scaled; snout, maxillary, head and body completely scaled.

Color-pattern lacking in alcoholic specimens, save for three indistinct yellowish stripes running longitudinally along body, the second through the eye; bases of dorsal and anal of similar color.

This species very greatly resembles *Zalanthias* or *Pseudanthias venator* Snyder, differing mainly in the remarkable fact that in the latter the bases of the vertical fins are not scaled, save for a " low sheath " at the base of the soft dorsal. From *Franzia nobilis* it is distinguished by the lack of the elongated dorsal spine, by the color, proportions of fins, etc.

136. **Sacura margaritacea** (Hilgendorf).

Misaki, Nos. 6174a–b.

Some specimens with, others without, a large black spot on body. *Anthias pulcher* Döderlein, characterized by the presence of this mark, is doubtless the same as *Sacura* or *Anthias margaritacea*, in which the spot is wanting.

137. **Zalanthias azumanus** (Jordan & Richardson).

(*Anthias japonicus* Hilgendorf, the name pre-occupied.)

Misaki, No. 6169a–c.

138. **Pikea japonica** (Döderlein).

(Coll. Owston) Boshu, No. 4168a; Yenoshima, Sagami Bay, No. 4238a.

Family LOBOTIDÆ.

139. **Lobotes surinamensis** (Bloch).

Matsushima, a large example seen, the second known from Japan. It is known locally as Matsudai (Pine-cone porgy).

Family LUTIANIDÆ.

140. **Lutianus quinquelineatus** (Bloch).

Kominato, No. 6349a, Oshima Island (off Sagami Bay).

This specimen from Oshima corresponds entirely with specimens from the East Indies. A strong interopercular knob and preopercular notch are present; dorsal surface of head scaled to above eyes; no lingual teeth; vomer with a Λ-shaped band of teeth; lateral stripes narrow, five in number, three upper converging to upper edge of eye (not as in *L. kasmira*); sixty-five scales above lateral line, fifty-five below in longitudinal series; the rows of scales above the lateral line oblique. This is the fish described and figured by Bloch. It differs from *L. kasmira* in having larger scales, narrower body-bands, and in the different distribution of the latter. It has not been recorded from Japan since the time of Bloch.

141. **Lutianus russelli** (Bleeker).
Osaka, No. 6394a.

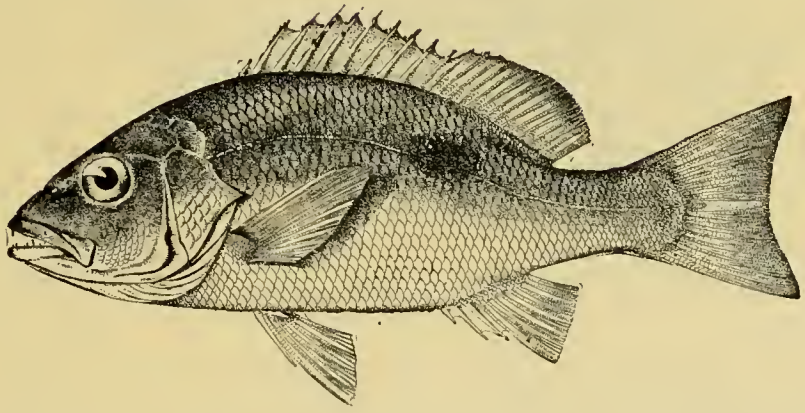


FIG. 24. *Lutianus russelli* Bleeker. (From Proc. U. S. N. M., Vol. XXXIX, p. 451).

142. **Lutianus vitta** (Quoy & Gaimard).
Osaka, No. 6378a.

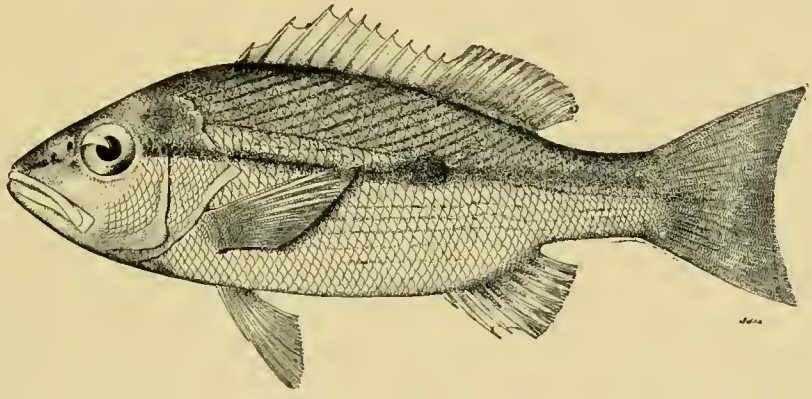


FIG. 25. *Lutianus vitta* (Quoy & Gaimard). (From Proc. U. S. N. M., Vol. XXXIX, p. 449).

143. **Pristipomoides sieboldi** (Bleeker).
(Coll. Owston) Sagami Bay, No. 4268a–d.

144. **Doderleinia berycoides** (Hilgendorf).
Odawara, Straits of Tsushima, in deep water, No. 6389a; found in the Zakoba market at Osaka, No. 6316a–b.

Four young specimens. The pre-opercle is set with long, rather weak spines, strongest at the angle.

145. **Euthyopteroma virgatum** (Houttuyn).
Osaka, No. 6310a–d.

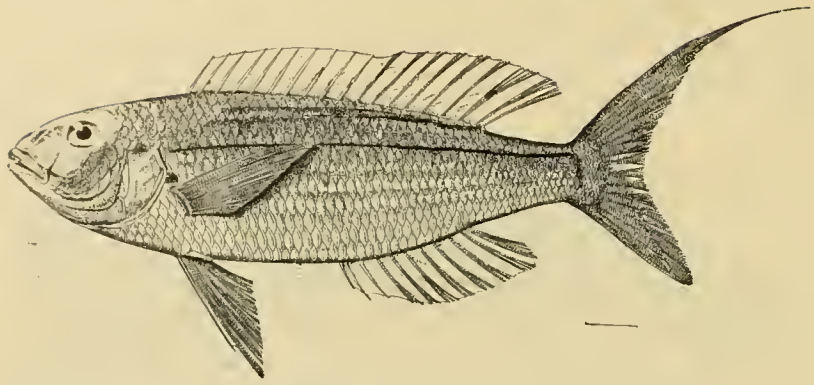


Fig. 26. *Euthyopteroma virgatum* (Houttuyn). (From Proc. U. S. N. M., Vol. XLI, p. 565).

Family HÆMULIDÆ.

146. **Therapon ocyrhynchus** Temminck & Schlegel.
Okayama (Kusano and Otaki), No. 6273a–b; Osaka.

147. **Parapristipoma trilineatum** (Thunberg).
Osaka, No. 6376a–b.

148. **Plectorhynchus pica** (Cuvier & Valenciennes). (Plate XXX, fig. 2).

One specimen No. 6018a, 100 mm. in total length, 73 mm. in length without caudal, from Boshu, Japan.

The color and proportions of this fish show the typical variations of the young of these forms. The caudal is elongate and pointed, the spines high, and the color-bands broad. The latter, as is known in allied forms, break up and disappear with age, or become narrowed. *Diagramma orientale* Cuvier and Valenciennes (Hist. Nat. des. Poiss., plate 124) shows almost identically the coloration of the present specimen, but differs in showing thirteen spines and larger scales. *Plectorhynchus pica* (*Cf.* Günther, Fische Südsee, Plate XXII, fig. A) corresponds very closely with the present specimen in all particulars, save a deeper pre-orbital in the plate given by Günther, which is not accurate in proportions. We here describe and figure our specimen, as it is apparently rare and not hitherto known from Japan. Most members of this group have a wide distribution.

Head 3.4 in body-length without caudal; depth 3.25; D. XII, 20; A. III, 7; scales ninety-seven in series below lateral line, fourteen between latter and dorsal insertion, twenty-two between lateral line and anal insertion; profile from snout to dorsal insertion strongly arched, nearly straight along dorsal base; pre-orbital depth two-thirds diameter of eye; snout 3 in head; eye 3 in head, equalling maxillary, which reaches anterior border of eye; teeth in villiform bands in both jaws, outer rows slightly enlarged; pre-opercle coarsely serrate.

Spinous dorsals rounded, third to fifth longest, 2.33 in head; pectorals 1.5 in head; ventrals same; caudal elongate, as is typical of the young of these forms.

Scales absent on snout, jaws, maxillary, and anterior three-quarters of preorbital, present on bases of soft fins, in a sheath at base of spinous dorsal; everywhere ctenoid; mandibular rami each with five large pores.

Color-pattern striking, of contrasting dark brown and white; belly and lower portion of sides white from last anal ray to throat and above level of pectoral; snout white from tip to a line from vertical of anterior margin of eye including all of maxillary and lower jaw; a large white saddle extending as far down as lateral line on nape, another at base of last three dorsal spines and first three rays of similar extent; caudal peduncle with broad white cross-band; upper rays of caudal white, save on base; anal, pectoral, and ventrals colorless; soft dorsals colorless on distal half; spinous dorsal black, save for last three spines; all other parts of body a deep brownish black, pattern everywhere clear cut with even margins, nowhere diffuse or indefinite.

149. **Plectorhynchus cinctus** (Temminck & Schlegel).
Kobe, No. 6205a (Coll. Manabe).

150. **Plectorhynchus pictus** (Thunberg).
Sagami Bay, No. 6154a; Misaki, tide-pools, No. 6043a.

151. **Hapalogenys mucronatus** (Eydoux & Souleyet).
Osaka, No. 6375a–e.

152. **Hapalogenys nigripinnis** (Temminck & Schlegel).
Misaki, No. 6406a.

A specimen everywhere intensely black in color on fins and body, save for lighter shades on breast.

Family BANJOSIDÆ.

153. **Banjos banjos** (Richardson).
Misaki, No. 6058a, young in the tide-pools.

Traces of seven or eight dark stripes on body, an interrupted band across nape, along edge of opercle, another from eye across maxillary; snout and head mottled with dark color; spinous dorsal black distally, a broad black stripe along base; body-bands continued on soft dorsal; a black spot between second anal spine and first soft ray; ventrals black; pectoral with a spot at base.

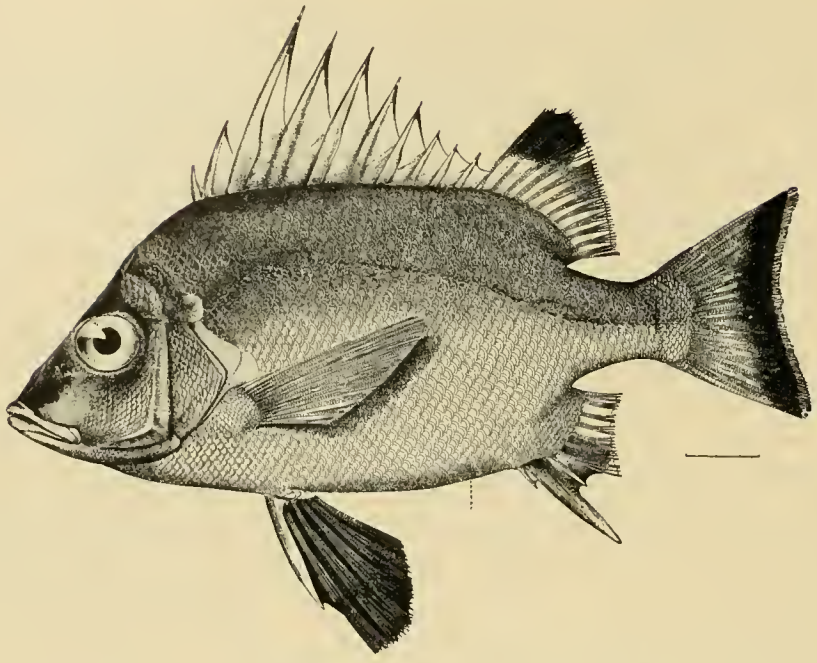


Fig. 27. *Banjos banjos* (Richardson). (From Proc. U. S. N. M., Vol. XLI, p. 541).

Family SPARIDÆ.

154. **Pagrosomus major** (Temminck & Schlegel).

(Mem. Carn. Mus., Vol. VI, p. 34, fig. 24).

Misaki, No. 6191a–d; Shimonoseki, Kobe, No. 6366a; Osaka, Yokohama, Sendai.

The young of this species is readily known from related species by having a black spot on base of pectoral.

155. **Evynnis cardinalis** (Lacépède).

Misaki, No. 6439a–d; Osaka, No. 6391a.

156. **Raius tumifrons** (Temminck & Schlegel).

(Mem. Carn. Mus., Vol. VI, p. 35, fig. 25).

Misaki, Tsushima Straits, No. 6371a–f.

This species makes the bulk of the fishing of the trawlers between Tsushima and Shimonoseki. They are sent frozen to the Osaka market.

Color light crimson, the nose yellow, a diffuse yellow blotch below middle of base of dorsal.

157. **Sparus latus** Houttuyn.

Osaka, No. 6298a–g.

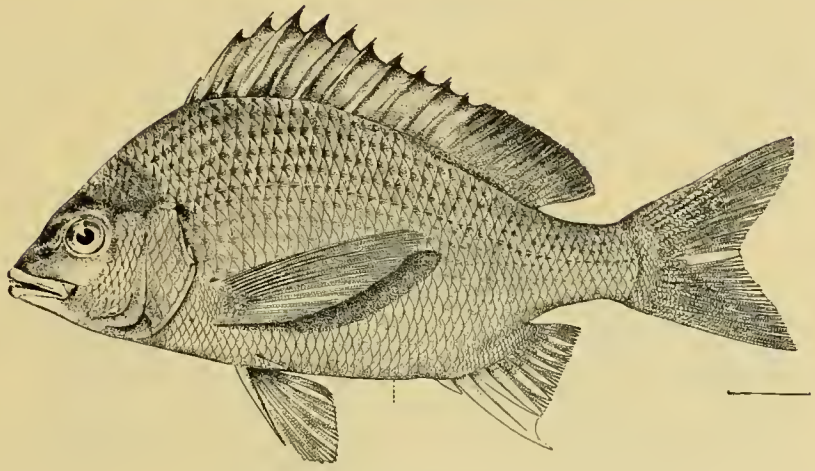


FIG. 28. *Sparus latus* Houttuyn. (From Proc. U. S. N. M., Vol. XLI, p. 584).

158. **Sparus macrocephalus** Basilewsky.
(Mem. Carn. Mus., Vol. VI, p. 35, fig. 26).
(*Chrysophyrs swinhonis* Günther.)
Matsushima Bay, No. 6428a; Shimonoseki, No. 6396a–g; Osaka.

Family KYPHOSIDÆ.

159. **Kyphosus cinerascens** (Forskål).
Misaki, No. 6067a. A young example, 67 mm. long.
D. XI, 12; A. III, 11. Identical with a specimen from Calayan in the Philippines. Only twice before recorded from Japan.

160. **Girella mezina** Jordan & Starks.
Misaki, No. 6132a.

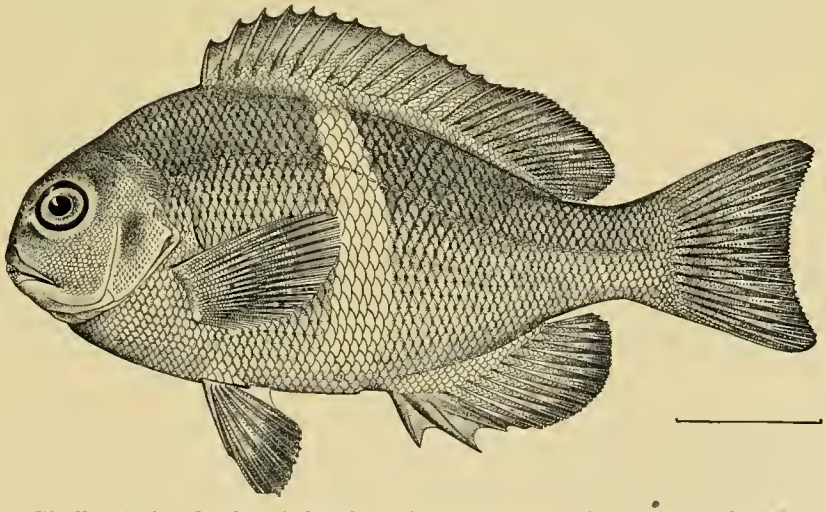


FIG. 29. *Girella mezina* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXXII, p. 497).

Fourteen centimeters long. The white band seen in the type is missing, doubtless disappearing with age.

161. **Girella punctata** Gray.
Kobe, No. 6335a; Misaki, No. 140a–b; Osaka, No. 6268a,

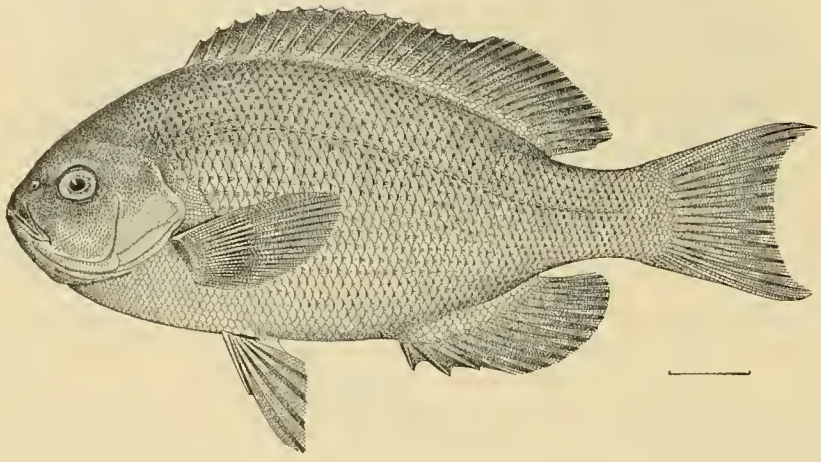


Fig. 30. *Girella punctata* Gray. (From Proc. U. S. N. M., Vol. XXII, p. 498).

162. **Girella melanichthys** (Richardson).
Misaki, No. 6203a–c.

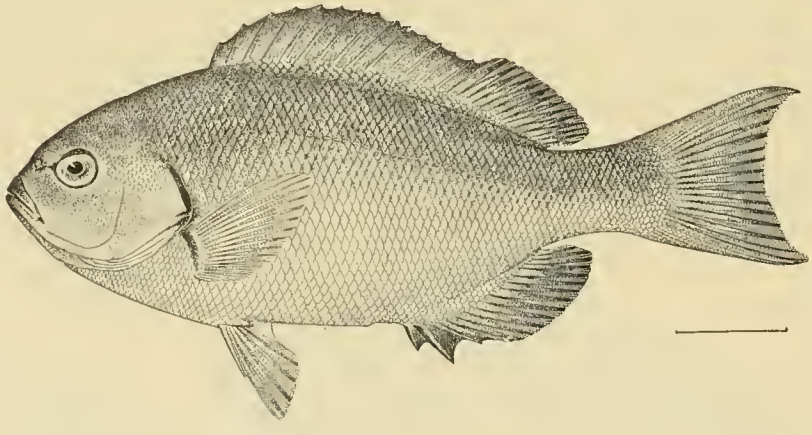


Fig. 31. *Girella melanichthys* (Richardson). (From Proc. U. S. N. M., Vol. XXXII, p. 498).

Family SCIÆNIDÆ.

163. **Sciæna mitsukurii** (Jordan and Snyder). (Plate XLII, fig. 1).
Sendai.

164. **Sciæna schlegeli** (Bleeker).
Matsushima Bay; No. 6297a; Osaka, No. 6347a–g.

Family OPLEGNATHIDÆ.

165. **Oplegnathus fasciatus** (Temminck & Schlegel).
Shimonoseki, No. 6337a–i; Kobe, No. 6209a–c (Coll. Manabe); Misaki, No. 6407a.

166. **Oplegnathus punctatus** (Temminck & Schlegel).
Osaka, No. 6369a.

Family HISTIOPTERIDÆ.

167. **Histiopterus typus** (Temminck & Schlegel).
Misaki, No. 6247a.

Family PRIACANTHIDÆ.

168. **Pseudopriacanthus niphonius** (Cuvier & Valenciennes).
Misaki, No. 6074a–c; Sagami Bay.
Found at Misaki in tide-pools. Young three centimeters long. Dark cross-bands very wide, five or six times width of interspaces. Spinous dorsal and anal black, as are pectorals and ventrals. Soft vertical fins clear, with small vivid black oblong spots.

Family MULLIDÆ.

169. **Upeneus spilurus** (Bleeker).
Misaki, No. 6106a.
Three dark stripes barely visible. Eye 4.2 in head; depth of caudal peduncle 8.5 in body-length.

170. **Upeneus bensasi** (Temminck & Schlegel).
(Mem. Carn. Mus., Vol. VI, p. 40, fig. 32).
Misaki, No. 6181a; Awaji Island.

Family APLODACTYLIDÆ.

171. **Goniistius zonatus** (Cuvier & Valenciennes).
(Mem. Carn. Mus., Vol. VI, p. 41, fig. 34).
Misaki, No. 6263a; Enoshima, No. 6073a.

Family POLYNEMIDÆ.

172. **Polydactylus agonasi** (Jordan and McGregor).
(Mem. Carn. Mus., Vol. VI, p. 40, fig. 33).
Osaka.

Family SILLAGINIDÆ.

173. **Sillago sihama** (Forskål).
Misaki, No. 6166a–b.

174. **Sillago japonica** (Temminck & Schlegel).
Osaka, No. 6235a; Shimonoseki, No. 6218a–b.

Family LATILIDÆ.

175. **Latilus japonicus** (Houttuyn).
Misaki, No. 6149a–b; Osaka, No. 6304a.

Family MALACANTHIDÆ.

176. **Oceanops latovittata** (Lacépède).
Nafa, Okinawa, Riu Kiu (in collection of the Kwansei Gakuin at Kobe).

Family ECHENEIDIDÆ.

177. **Rhombochirus megalodiscus** (Franz).
One specimen, Misaki, No. 6274a.
Disk 2.8 in body-length to base of caudal. Eye 8 in head; otherwise as in Franz's figure. D. XVIII–22, A. 20.

178. **Remorina brachyptera** (Lowe).
Misaki, No. 6223a; Matsushima Bay; Sendai, No. 6295a.

Family CEPOLIDÆ.

179. **Acanthocepola limbata** (Cuvier & Valenciennes).
Misaki, No. 6435a.
Head 10.5 in length; depth 14. Eye 3 in head, snout 4.5; D. 103, A. 101. Scales four hundred and twenty or more. This agrees in all regards with the account given by Jordan and Evermann (Proc. U. S. N. M. XXV, 1902, p. 363) of a specimen from Formosa called *Acanthocepola mesaprion*.

180. **Cepola schlegeli** (Bleeker).
Misaki, No. 6060a.
Head 7.5; depth 10; D. 65; A. 64; three hundred and seventy scales. Eye 2.66 in head; snout 5.33. Maxillary reaching posterior border of pupil; a black spot between maxillary and premaxillary.

Family EMBIOTOCIDÆ.

181. **Ditrema temmincki** Bleeker.
(Mem. Carn. Mus., Vol. VII, p. 42, fig. 36).
Shimonoseki; Osaka, No. 6404a; Misaki, No. 6397a–c.

182. **Neoditrema ransonneti** Steindachner.
(Mem. Carn. Mus., Vol. VI, p. 43, fig. 37).
Misaki, No. 6423a–c.

Family POMACENTRIDÆ.

183. **Chromis notatus** (Temminck & Schlegel).
Kobe, No. 6230a–c (Coll. Manabe).

184. **Abudefduf sordidus** (Forskål).
Misaki, No. 6146 many; 125 cm. long. Also numerous young from tide-pools.

185. **Abudefduf saxatilis** (Forskål).
Misaki, No. 6077 many.

Family LABRIDÆ.

186. **Chœrodon azurio** (Jordan & Snyder).
Shimonoseki, Osaka, No. 6387a.

187. **Semicossyphus reticulatus** (Cuvier & Valenciennes).
(Mem. Carn. Mus., Vol. VI, p. 43, fig. 38).
Shimonoseki.

188. **Lepidaplois perditio** (Quoy & Gaimard).

Two young specimens, No. 6308a–b, the longest 18 cm., from an unknown locality, probably Misaki.

The color is pale, the black blotch under the dorsal very distinct, extending on the rays. The pale area before it is obscure. The black spots between the

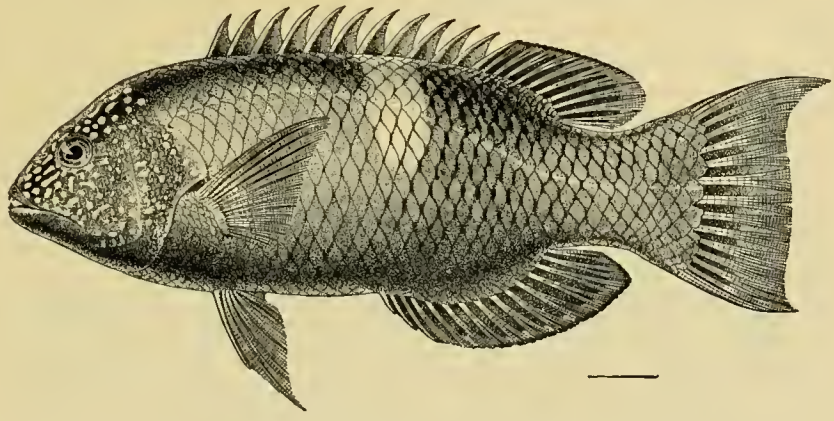


Fig. 32. *Lepidaplois perditio* (Quoy & Gaimard). (From Proc. U. S. N. M., Vol. XXIV, p. 618).

dorsal spines are very distinct. Head with violet reticulations around pale spots. The large specimens taken by Jordan and Snyder at Wakanoura are much deeper in color, verging on violet. *Cossyphus atrolumbus* Cuvier & Valenciennes is doubtless based on young examples like these. The figure of *L. perditio* given by Quoy & Gaimard from a sketch made by Quoy, when his ship was apparently being wrecked on the reefs of Tonga-tabu, is clearly incorrect; the black spot and the pale area are both wrongly placed.

D. XII, 10; A. 111, 12; Scales 5–34–13; head 3.5; depth 2.5.

189. **Lepidaplois macrurus** (Lacépède).
From Owston Collection; No. 4250a. (No label, probably from Okinawa).

190. **Pseudolabrus japonicus** (Houttuyn).
Misaki, No. 6158a–g; Shimonoseki, No. 6197a–b, ♀, 6202 a–b, ♂; Izu.

191. **Pseudolabrus gracilis** (Steindachner).
Misaki.

192. **Cirrhilabrus temmincki** Bleeker.
Misaki, No. 6458.
Young example with the ventrals not elongate; fins darker than usual.

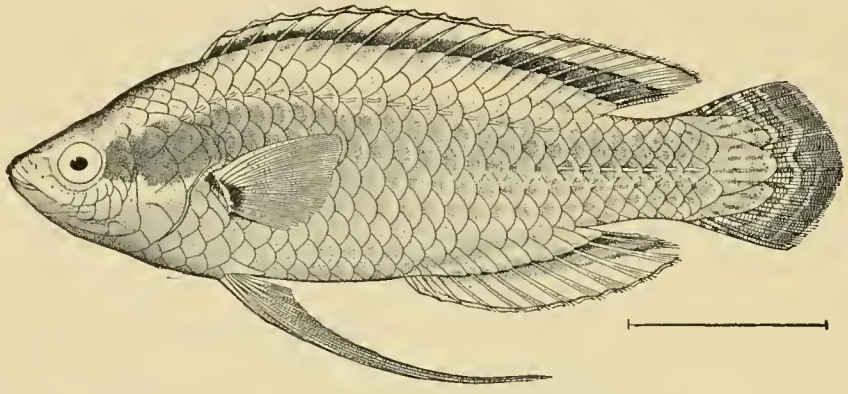


Fig. 33. *Cirrhilabrus temmincki* Bleeker. (From Proc. U. S. N. M., Vol. XXIV, p. 652).

193. **Stethojulis terina** Jordan & Snyder.
(Coll. Owston) Izu, No. 4305a.

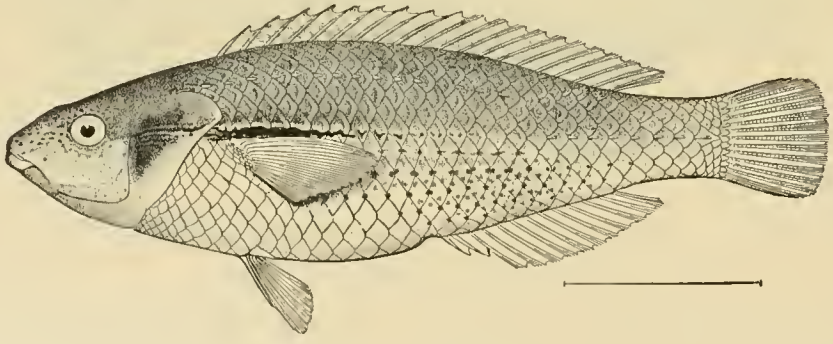


Fig. 34. *Stethojulis terina* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 632).

This is probably the female of the species called *Stethojulis trossula.*

194. **Stethojulis trossula** (Jordan & Snyder).
Izu, No. 4264a–b; Owston collection.

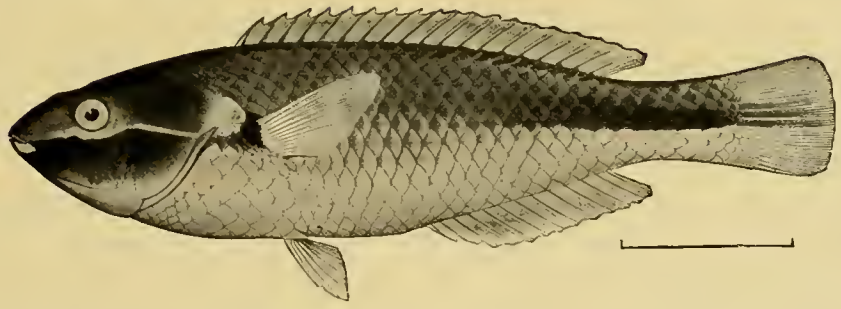


FIG. 35. *Stethojulis trossula* (Jordan & Snyder). (From Proc. U. S. N. M., Vol. XXIV, p. 633).

195. **Halichoeres poecilopterus** (Temminck & Schlegel).

Misaki, No. 6247a–c; Shimonoseki, No. 6266a–b; Osaka, No. 6186a–d.

This seems to be the male, and the form called *H. pyrrhogrammus* is probably the female of the same species.

196. **Julis musume** (Jordan & Snyder).

From Owston Collection, No. 4115a, Okinose, Sagami Bay.

197. **Thalassoma cupido** (Temminck & Schlegel).

Misaki, No. 6425a.

198. **Xyrichthys sciistius**, sp. nov. (Plate XXX, fig. 3).

The following is a description of the type, 165 mm. long, from Sagami Bay, No. 6028, C. M. Cat. of Fishes:

Head 3.33 in body, without caudal; depth 2.66; eye 6 in head; preorbital depth 4.25; maxillary 3.4; depth of caudal peduncle 2; D. IX, 12; A. III, 12; scales in lateral series twenty-five; in transverse series at middle of body 2.5/9.5.

Eye set low in head, at diameter of an eye from dorsal profile and at the level of origin of lateral line; dorsal edge of snout and head moderately carinate, evenly arched from snout to dorsal origin, not more so on nape; distance from eye to dorsal origin greater than depth of pre-orbital; latter one and two-thirds diameter of eye; maxillary nearly reaching vertical from eye; cheek without furrow from end of maxillary; teeth of both jaws in three or four rows, the outer conical and slightly enlarged, the inner two granular and small; two forward pointing canines in each jaw in front, a single smaller canine in the center of each side of the lower jaw; no posterior canine; gill-rakers eleven on lower limb of first arch.

First two dorsal spines of very slightly greater height than the following, subequal, about 3 in head; soft rays 2.5 in head; anal similar to soft dorsal; its spines short, graduated; vent decidedly nearer snout than base of caudal; ventrals 1.33 in head, slightly filamentous, reaching anal insertion; pectorals 1.5 in head.

Body colorless, probably light red or yellowish in life, save on membranes of spinous dorsal, on which is a row of spots of black; smaller spots are present at the same level on the spines; peritoneum colorless.

199. **Iniistius dea** (Temminck & Schlegel). (Plate XXXI, fig. 7).

Sagami Bay, No. 6008a; Misaki, No. 6296a–d; Yokohama, No. 6287a, 6377a–b.

A young specimen from Sagami Bay, but eighty-four millimeters in total length, shows the juvenile coloration well, and a figure is given on Plate XXXI. In the adults the bands are very faint and the coloration of the fins has entirely changed. At a length of one hundred and thirty millimeters the bands are slightly stronger in coloration. The closely allied species, *Iniistius pavoninus* of the Hawaiian Islands, shows an exactly similar change, the bands, however, being distinct in specimens reaching as much as one hundred and fifty-five millimeters in length. The pre-orbital depth is very much less in the young than in the adult. These changes we have followed in detail in *Iniistius pavoninus* and partially in *Iniistius dea*. The species are so closely allied that there is no question that the same laws of change in color apply. A careful comparison of a large series of specimens and measurements taken in hundredths of body-length showed no prominent differences between *Iniistius dea, I. pavoninus*, and *I. niger*, the principal differences being those of color.

Adult with head 3.33 to 3.5 in body; depth 2.66. Black lateral spot absent in two specimens.

Misaki, Yokohama (Coll. Owston).

Family SCARICHTHYIDÆ.

200. **Calotomus japonicus** (Cuvier & Valenciennes).

Misaki, No. 6187a–d.

Snout 3 in head; caudal narrowly edged with white.

Family ZEIDÆ.

201. **Zenopsis nebulosa** (Temminck & Schlegel).

Kobe.

202. **Zeus japonicus** (Cuvier & Valenciennes).

Tsushima Straits; Misaki, No. 6064a; Kobe, No. 6045a; Osaki, No. 6368a–d.

Family ANTIGONIIDÆ.

203. **Antigonia rubescens** (Günther).

Misaki, No. 6414a–e.

Family PLATACIDÆ.

204. **Platax teira** (Forskål).

One specimen from the Owston Collection, Okinose, Sagami Bay, No. 4146a.

Family CHÆTODONTIDÆ.

205. **Chætodon setifer** Bloch.

Misaki, No. 6152a.

Length eleven centimeters. This common species of the South Seas had not been previously noted in Japan.

206. **Chætodon lunula** (Lacépède).

Misaki, No. 6214a; Goto Islands, No. 6131a–b; from the Owston Collection. These specimens agree entirely with others from Samoa and Hawaii.

207. **Chætodon vagabundus** Linnæus.

Misaki, No. 6138a.

Young in the rock-pools at Yogashima.

208. **Microcanthus strigatus** (Cuvier & Valenciennes).

Misaki, No. 6356a–e.

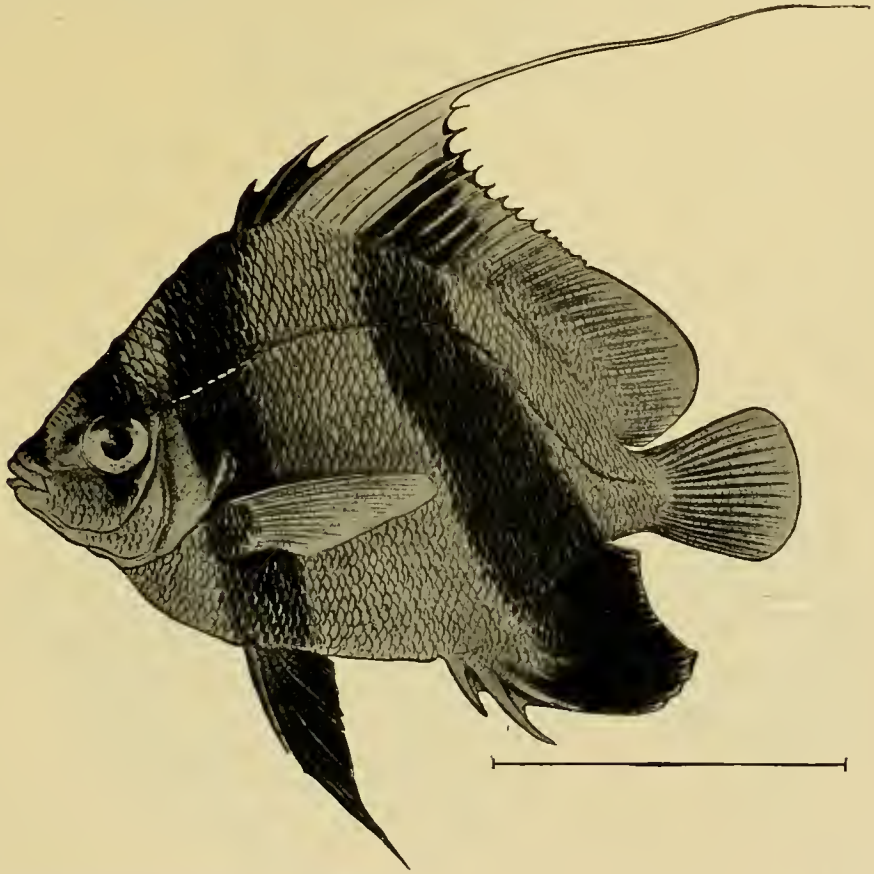


Fig. 36. *Heniochus macrolepidotus* (Linnæus). (From Proc. U. S. N. M., Vol. XXVI, p. 695).

209. **Heniochus macrolepidotus** (Linnæus). (See Fig. 36, p. 265).
Misaki, No. 6144a–j.

Family HEPATIDÆ.

210. **Naseus unicornis** (Forskål).
Misaki, No. 6136a.
Young example without frontal horn or caudal plate; D. V–27; A. II, 27.

211. **Xesurus scalprum** (Cuvier & Valenciennes).
Yokohama; Izu; Misaki, No. 6408a–b.

212. **Hepatus argenteus** (Quoy & Gaimard).
Misaki, No. 7137a.

Family TEUTHIDIDÆ.

(Siganidæ).

213. **Teuthis fuscescens** (Houttuyn).
Osaka, No. 6380a; Kobe, No. 6157a.
Under the rules of the International Zoölogical Congress, *Teuthis* should replace *Siganus*. Originally *Teuthis* of Linnæus included *Hepatus* Gronow—*Acanthurus* Forskål. *Teuthis* was first restricted by Cuvier to *Teuthis javus*, which is a *Siganus* of Forskål.

Family TRIACANTHODIDÆ.

214. **Triacanthodes anomalus** (Temminck & Schlegel).
Misaki, No. 6143a.

Family TRIACANTHIDÆ.

215. **Triacanthus brevirostris** (Temminck & Schlegel).
Misaki, No. 6344a–b; Sagami Bay, No. 6362a–j.
D. V–22; A. 18; Head 3.75; depth 2.8. Black blotch around base of spinous dorsal as well as on fin.

Family MONACANTHIDÆ.

216. **Monacanthus cirrhifer** Temminck & Schlegel.
Shimoneseki, 6141a.

217. **Monacanthus japonicus** (Tilesius).
(Mem. Carn. Mus., Vol. VI, p. 44, fig. 39).
Kobe, No. 6044a–d (Coll. Manabe).

218. **Stephanolepis cirrhifer** (Temminck & Schlegel).
Yokohama, No. 6141a; Shimonoseki.
Color well-preserved; besides the usual minute longitudinal lines, two broad, very indistinct curved bands are present between the dorsal and anal, the convexities forward.

219. **Pseudomonacanthus nigromaculatus** (Tanaka). (Plate XXXI, fig. 2).

Sagami Bay, No. 6365a; otherwise known only from Tanaka's type. We figure our example of this interesting species.

220. **Rudarius ercodes** Jordan & Fowler.

Misaki, No. 6139a–o.

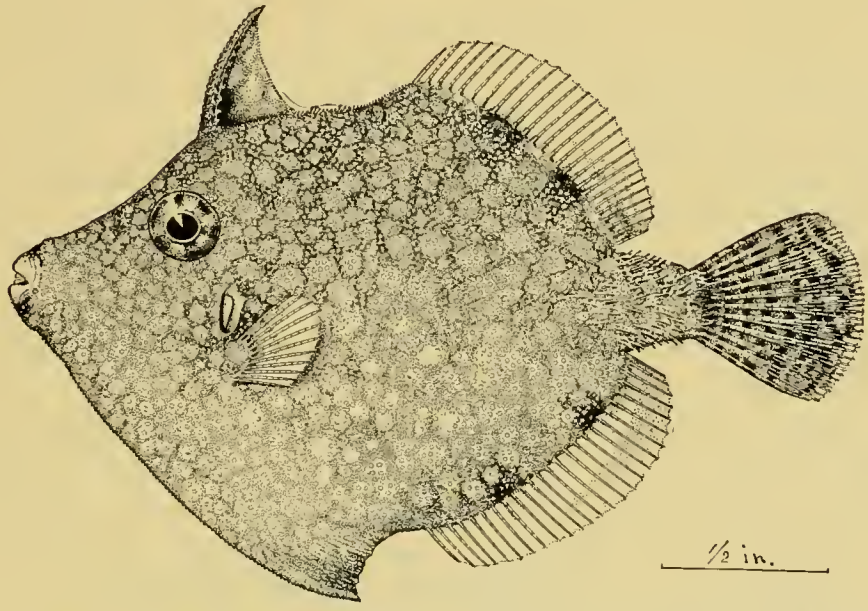


FIG. 37. *Rudarius ercodes* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXV, p. 270).

221. **Brachaluteres ulvarum** Jordan & Snyder.

Misaki, No. 6145a.

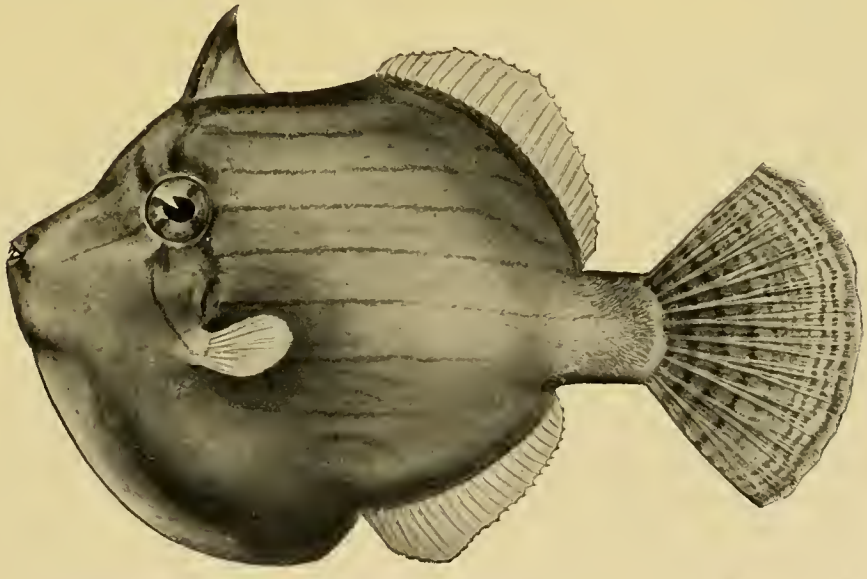


FIG. 38. *Brachaluteres ulvarum* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXV, p. 272).

Family OSTRACIIDÆ.

222. **Ostracion diaphanum** Bloch & Schneider.

Misaki, No. 6151a–c.

223. **Ostracion stellifer** Bloch & Schneider.

(*Lactophys tritropis* Snyder).

One specimen, No. 6447a, 8 cm. long, from Misaki. This is identical with the cotypes of *Lactophrys tritropis* Snyder,[3] No. 21424 Stanford University Collection, with which it was compared. It was also compared with a specimen of *L. stellifer* (Bloch) from Sydney and found identical in all respects, save the slightly smoother appearance of the scales; counts, measurements, color, spines, and shape were the same. The cotypes of *L. tritropis* Snyder, and the specimen at hand, are probably the young of the species erroneously termed *Lactophrys concatenatus* (Bloch). The original of the latter was a West Indian species, identical with *Ostracion triqueter* Linnæus, Bloch having described it and copied his plate from a drawing by Plümer of a specimen from Martinique.[4]

The name *Ostracion stellifer* Bloch & Schneider is then the oldest name of the species, and must be used instead of *concatenatum* (Bloch). The species is recorded as *stellifer* by Bleeker from Japan, but the earliest reference we have found is in his "Nieuwe Nalezingen"[5] without locality other than Japan. In later lists it was evidently termed *Ostracion concatenatum*.

224. **Ostracion immaculatum** Temminck & Schlegel.

Misaki, No. 6260a–f.

A small specimen has black spots on dorsal and lateral surfaces; the others are normally colored.

225. **Ostracion fornasini** Bianconi.

Misaki (Coll. Aoki).

One young example identical with one from Lord Howe Island. Irregular spots and lines of pigment over head and upper half of body. This species has not before been noticed in Japan.

226. **Aracana aculeata** (Houttuyn).

Misaki.

Lateral ridges in young with five small spines, ventral with six.

[3] Proc. U. S. N. Mus., Vol. XL., p. 536, 1912.

[4] See Jordan & Evermann, Fish. N. &. M. America, Vol. II, p. 1723 (= *L. triqueter*).

[5] Verh. Bot. Genoot., XXVI, p. 40, 1857.

Family TETRAODONTIDÆ.

227. **Spheroides spadiceus** (Richardson).

Osaka, No. 6430a–b; Shimonoseki, No. 6179a–c.

Three young; some with a dark blotch at base of dorsal, upper jaw-teeth grooved, with parallel ridges.

228. **Spheroides pœcilonotus** (Temminck & Schlegel).

Shimonoseki, No. 6175a.

Spots above pectorals confluent across the back. The pore-line across the nose is convex anteriorly, not posteriorly, as described and figured by Richardson, whose Chinese fish *alboplumbeus* is probably different from the Japanese form called *pœcilonotus*. The specimen called *Spheroides ocellatus* by Jordan and Evermann, from Formosa, is the same species as this.

229. **Spheroides pardalis** (Temminck & Schlegel).

Shimonoseki, No. 6269a.

230. **Spheroides chrysops** (Hilgendorf).

Misaki, No. 6150a.

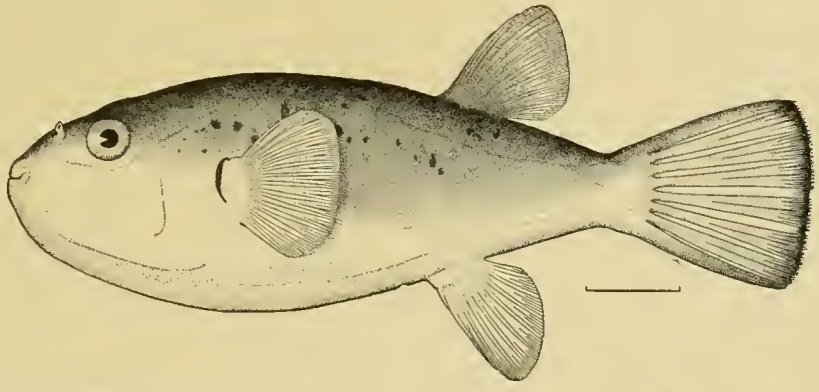


Fig. 39. *Spheroides chrysops* (Hilgendorf). (From Proc. U. S. N. M., Vol. XXIV, p. 249).

Distinguished from other species of the genus by the short and deep caudal peduncle, the extension of the pectoral over half-way to dorsal, and by the color.

231. **Spheroides borealis** Jordan & Snyder.

(Mem. Carn. Mus., Vol. VI, fig. 41, p. 46).

Misaki, No. 6116a.

232. **Canthigaster rivulatus** (Temminck & Schlegel).

Misaki, No. 6163a–d.

Family SCORPÆNIDÆ.

233. **Sebastodes owstoni** sp. nov. (Plate XXI, fig. 3).

Described from the type, No. 6025 Carnegie Museum Catalog of Fishes, a specimen from Aomori, Japan, 178 mm. in total length. Three cotypes, No. 6030a–c, are from the same locality.

Head 2.9 in body without caudal; depth 3.5; eye 3.33 in head; maxillary 2.33; interorbital space 4.5; snout 3.5; D. XIV, 13 (or 14); A. III, 8 (or 9); pores in lateral line 35; scales in longitudinal series 55 (60) (counting oblique rows); in transverse 6 from insertion of dorsal to lateral line, 16 from insertion of anal to lateral line.

Body elongate, slender; snout pointed; lower jaw with prominent symphyseal knob; maxillary reaching vertical from center of eye; interorbital space broad, but very slightly convex; nasal spines small, but sharp; pre-ocular spines of moderate size, sharp; orbital rim not raised; supra-ocular and parietal ridges visible, not covered by scales, each terminating in a very small sharp spine, as does nuchal ridge; pre-opercle with five flat spines; pre-orbital with a single sharp serration on lower border. Teeth in a single series on mandibles, a patch on symphyseal knob; in narrow bands in upper jaw.

Dorsal spines high, fifth and highest, 2.25 in head; last spine a half longer than penultimate; anal spines very long, second longest, 2 in head; pectorals reaching anal insertion, as long as head; ventrals extending to anus, two-thirds head; tip of last anal ray, when supine, reaching to diameter of eye from first caudal ray; caudal deeply emarginate, nearly forked.

Color in alcohol uniformly reddish, no black on fins or body. In some specimens there are faint indications of a blackish blotch below ninth to twelfth dorsal spines and another below middle of soft dorsal.

This species is most nearly allied to *Sebastodes itinus* Jordan and Starks, with the type of which it was compared. The differences are as follows: a lesser number of lateral line pores in *S. owstoni*, more prominent head armature, longer anal spines, and longer pectoral, as well as numerous small differences in proportions.

234. **Sebastodes flammeus** Jordan and Starks. (Plate XXXII, fig. 1).

Two fine specimens of this species from the Hokkaido, three hundred and thirty-seven and four hundred and seventeen millimeters in total length, No. 6463. The type only has hitherto been known, a very poorly preserved specimen without skin, the head stripped of skin and flesh, and the soft rays broken off. The unnatural prominence of the head armature led Jordan and Starks to regard it as allied to *S. iracundus*, but it is more nearly allied to *S. steindachneri*, the spines and cranial ridges being nearly obscured by the flesh and skin in both.

From *S. steindachneri* it differs in the scaled mandibles and tip of snout, and the dentition. A series of measurements taken of the type and of our specimens in hundredths of body-length are here given, as the type is very fragile and liable to destruction. The measurements of the type are included in parentheses:

Head without mandible .37 (.39); depth .31 (.31); eye .095–.11 (.105); maxillary length .175 (.175); snout .09–.095 (.09); mandible .20 (.21); pectoral .27 (.28) ventral rays .19; ventral spine .11–.12 (.14); fourth dorsal spine .105–.112 (.135); third anal spine .10 (.14); interorbital space .08–.085 (.083); pores in lateral line 31–33; least depth of caudal peduncle .08–.09 (.085); D. XIII., 14; A. III., 8.

Pectoral reaching to vent or to anal insertion; ventrals not reaching vent by two-thirds of eye or more; caudal emarginate; longest dorsal rays 2.5 in head, without mandible; longest anal rays 2.33.

Spines on head very small, merely the sharp tip of each projecting above the skin, save those of the parietals, which have a low naked ridge. Scales ctenoid, present on whole of body, including tip of snout, maxillaries, mandibles, and basal half of soft vertical fins. Spinous dorsal set in a narrow naked space, no scales on its base, about seven or eight scales between lateral line and edge of naked area. Scales above lateral line about 75; only 31–33 with pores. Gill-rakers 9+20.

Color in alcohol uniform, apparently red in life, a dark blotch on opercular flap; caudal a trifle dusky, and traces of a black margin on spinous dorsal. Peritoneum and lining of gill-cavity black.

The specimens show a variation in the lengths of fins and spines according to their relative size, the larger specimens having the shorter fins.

In the original description of the type it was not mentioned that the teeth in the upper jaw form a villiform band posteriorly.

235. **Sebastodes inermis** (Cuvier & Valenciennes).

Osaka, No. 6264a.

We do not find any permanent differences by which *Sebastodes güntheri* Jordan & Starks (Mem. Carn. Mus., Vol. VI, fig. 43, p. 49) can be separated from *S. inermis*.

236. **Sebastodes tokionis** Jordan & Starks. (See Fig. 40, p. 272).

Misaki, No. 6198a–d.

237. **Sebastodes joyneri** (Günther). (Plate XXXII, fig. 2).

Tsushima Straits; Osaka Market, No. 6037a–g; Miyako.

This species is rather common in Southern Japan. Our specimens are like those called *S. joyneri* by Jordan & Starks. But they differ considerably in color

from Günther's plate. This was possibly drawn from a different and otherwise unknown species, but more likely the plate, if correct, represents the young. We present a figure of a specimen from Tsushima straits.

238. **Sebastodes matsubaræ** (Hilgendorf).

Uraga channel (Coll. Owston).

239. **Thysanichthys evides** sp. nov. (Plate XXXII, fig. 3).

We base the accompanying description upon six specimens from Misaki, the type, the longest, 95 mm. in total length, being No. 6019a, Carnegie Museum Catalog of Fishes:

Head 2.5 in body-length; depth equal to head; eye 3.33 in head; snout 4; interorbital space 3; maxillary 1.8; pores in lateral line 22; scales, counting vertical

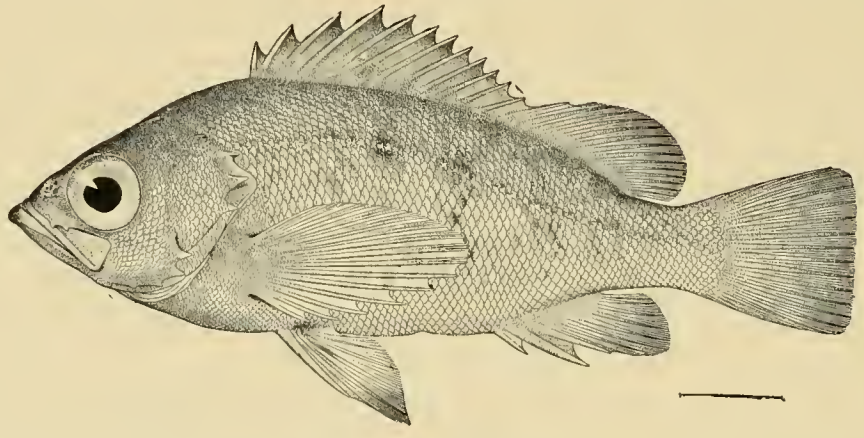


Fig. 40. *Sebastodes tokionis* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVII, p. 104).

rows above lateral line, 45; in transverse series, from insertion of anal to last dorsal spines, 5/11; D. XIII., 10; A. III., 6.

Armature of head more developed than in *Sebastichthys elegans;* nasal, pre-ocular, supra-ocular, post-ocular, tympanic, parietal, nuchal and coronal spines present, the latter small, all very acute and all prominent; pre-orbital with three prominent triangular, blunt points, overlapping the maxillary; suborbital stay prominent, forming a naked sharp ridge below eye, ending at level of upper opercular spine in a small spine, the ridge with two small posteriorly directed spines (much less prominent than in *Thysaninchthys crossotus*). Pre-opercle with a double upper spine, another immediately below, and a third more distant. Opercle with two sharp, somewhat dorsally directed, spines of equal strength; a similar one on clavicle, on post-temporal, and a smaller one immediately before the latter. Interorbital space deeply concave, a pair of ridges separated by a sharply marked

channel, and ending occasionally in a spine. Maxillary ending below posterior margin of orbit (not below middle, as in *Thysanichthys crossotus* Jordan & Starks). Lower jaw not projecting. Gill-rakers short, 10 on anterior limb of arch.

Scales ctenoid, not present on snout and maxillary, between interorbital regions, present on cheeks and opercles; fins naked, save base of pectoral and soft fins; lateral line without series of filaments; which are present on spines of head in part, none as long as in *Thysanichthys crossotus*.

Pectoral reaching to first anal spine; ventrals nearly to anus; dorsal and anal spines with channels. Fifth dorsal spine highest, 2.6 in head, thirteenth 3.166 in head, twelfth slightly more than half of thirteenth; second anal spine longest and strongest, 2 in head. Peritoneum white.

Color in spirits dark olivaceous, vaguely mottled.

240. **Sebastichthys pachycephalus** (Temminck & Schlegel).

Misaki, No. 6224a–b.

Color very dark. D. XIII., 12; A. III., 7; pores 27.

241. **Sebastichthys elegans** (Steindachner & Döderlein).

(Mem. Carn. Mus., Vol. VI, fig. 45, p. 51).

Idzu Sea, No. 4325a–b; from Owston Collection, Yokohama; Shimonoseki.

242. **Sebastichthys mitsukurii** (Cramer).

Shimonoseki, No. 6213a–c.

243. **Sebastiscus albofasciatus** (Lacépède).

(*Sebastes marmoratus* Cuvier & Valenciennes).

A. Osaka, No. 6343a, 6346a–l. Comparison of numerous specimens fails to show any distinction, except in color, between the common shore-form of *Sebastiscus*, called *marmoratus*, and the form *albofasciatus*, taken in deeper water. The former is dull olive and brownish in color, the latter of vivid shades of red and pink. Both forms are very common and some specimens seem to intergrade.

B. Tsushima Straits: the bright red form called *albofasciatus* common in the trawlers' catches. None of these has the spine below the eye, supposed to distinguish the red form from *marmoratus* of the shore. The eye varies greatly in size.

C. Shimonoseki, Nos. 6204, 6345a–c. Both the orange deep sea form (*albofasciatus*) and the brown shore form (*marmoratus*).

D. Misaki, No. 6148a.

244. **Helicolenus emblemarius** Jordan & Starks. (See Fig. 41, p. 274).

Misaki, No. 6236a, young (Coll. Aoki).

245. **Helicolenus hilgendorfi** (Döderlein).

Misaki, No. 6241a.

Compared with *H. dactylopterus* from the coast of Delaware, it has a slightly smaller eye, and fewer transverse scales above the lateral line.

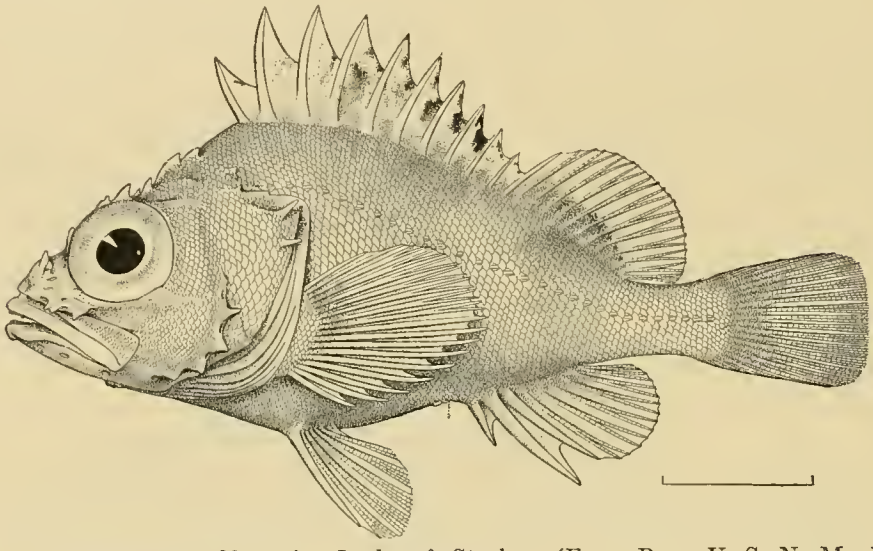


Fig. 41. *Helicolenus emblemarius* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVII, p. 130).

For the present we may regard the Japanese species as distinct.

246. **Scorpæna izensis** Jordan & Starks.

Straits of Tsushima in rather deep water, No. 6370a–f. (Osaka market). Hitherto known only by the types from Izu.

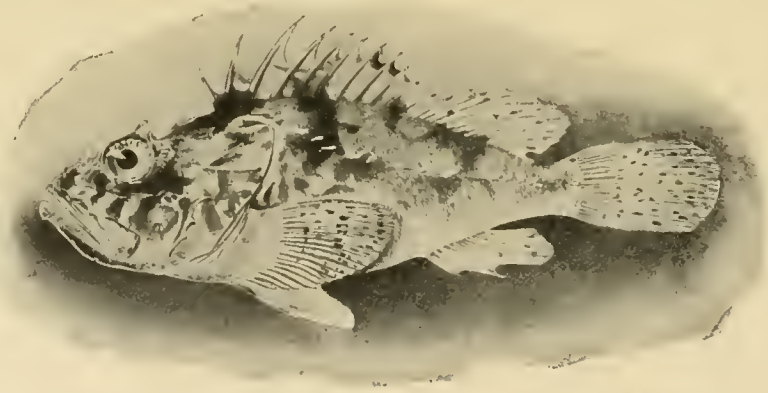


Fig. 42. *Scorpæna izensis* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVII, p. 134).

247. **Pterois lunulata** Temminck & Schlegel.

Misaki, No. 6165a–g; Yawatahama.

248. **Dendrochirus jordani** (Regan).

Misaki, No. 6211a–b.

Two specimens one hundred and forty millimeters long; D. XIII., 10; A. III., 7, P. 20; Scales 27. Head 2.75 in length; depth 3. Eye 3.5 in head; snout 2.5. Second ray of caudal filamentous. This is evidently the adult of the species named *Pterois jordani* by Regan.

249. **Paracentropogon rubripinnis** (Temminck & Schlegel).

Kobe, No. 6057a (Coll. Manabe); Misaki, No. 6253 many.

Fig. 43. *Paracentropogon rubripinnis* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXVII, p. 168).

250. **Apistus evolans** Jordan & Starks.

Misaki, No. 6417a.

Apistus venenans Jordan & Starks is not different from this specimen.

Fig. 44. *Apistus evolans* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVII, p. 147).

251. **Aploactis aspera** Richardson.
Misaki, No. 6120a (Coll. Aoki).

Fig. 45. *Aploactis aspera* Richardson. (From Proc. U. S. N. M., Vol. XXVIII, p. 172).

Head 3 in body; depth at ventrals 4. Eye 3.5 in head. D. III., X, 13; A. 14. Body everywhere very densely papillate.

252. **Erosa erosa** (Langsdorf).
Misaki, No. 6121a.

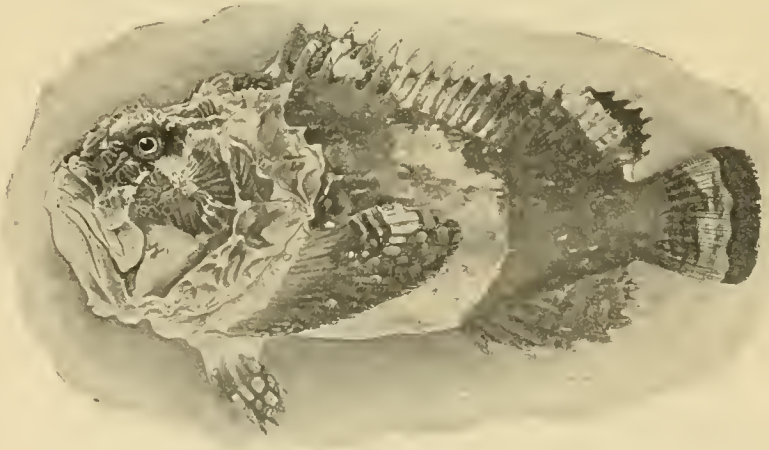


Fig. 46. *Erosa erosa* (Langsdorf). (From Proc. U. S. N. M., Vol. XXVII, p. 157).

253. **Minous monodactylus** (Bloch & Schneider). (See Fig. 47, p. 277).
(*Minous adamsi* Richardson).
Kobe, No. 6050 (Coll. Manabe).

The Japanese form called *Minous adamsi* is probably not different from the species found further south.

254. **Inimicus japonicus** (Cuvier & Valenciennes).
Misaki, No. 6341a–b.

FIG. 47. *Minous monodactylus* (Bloch & Schneider). (From Proc. U. S. N. M., Vol. XXVII, p. 153).

Family HEXAGRAMMIDÆ.

255. **Hexagrammos otakii** Jordan & Starks.
Osaka, No. 6314.

256. **Agrammus agrammus** (Temminck & Schlegel).
Kobe, No. 6156a (Coll. Manabe); Osake, No. 6302; Shimonoseki, No. 6199a.

Family COTTIDÆ.

257. **Cottus pollux** Günther.
Misaki, No. 6200a; Lake Biwa at Matsubara, No. 6220a–i.

258. **Furcina osimæ** Jordan & Starks.
Misaki, No. 6117 (Coll. Aoki).

FIG. 48. *Furcina osimæ* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXVII, p. 305).

Dorsal spines rather higher than in type; notch in spinous dorsal deeper; two stripes on soft dorsal.

259. **Pseudoblennius marmoratus** (Döderlein).
Misaki, No. 6244a–d.

260. **Pseudoblennius percoides** Günther.
Misaki, No. 6251a–e.

261. **Pseudoblennius cottoides** (Richardson).
Misaki, No. 6252a–f.

262. **Vellitor centropomus** (Richardson).
Misaki, No. 6072a–b.

Fig. 49. *Vellitor centropomus* (Richardson). (From Proc. U. S. N. M., Vol. XXVII, p. 320).

Family PLATYCEPHALIDÆ.

263. **Platycephalus indicus** (Linnæus).
Misaki, No. 6303a.

264. **Onigocia macrolepis** (Bleeker).
Misaki, No. 6069a–b; Yawatahama, in Iyo (Coll. Manabe).

265. **Onigocia spinosa** (Temminck & Schlegel).
Misaki, 6398a–d.

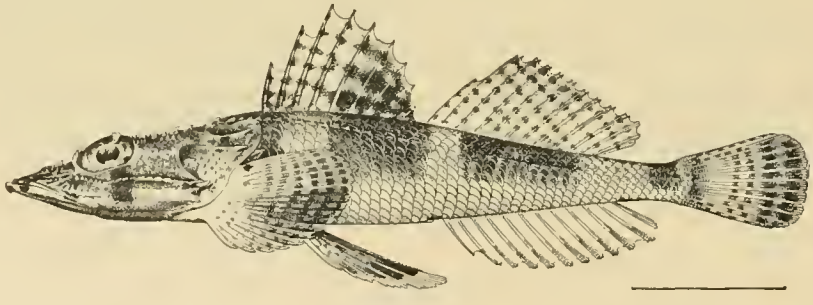


Fig. 50. *Onigocia spinosa* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXXIII, p. 633).

266. **Inegocia japonica** (Tilesius).
Misaki, No. 6188a, 6289a–b.

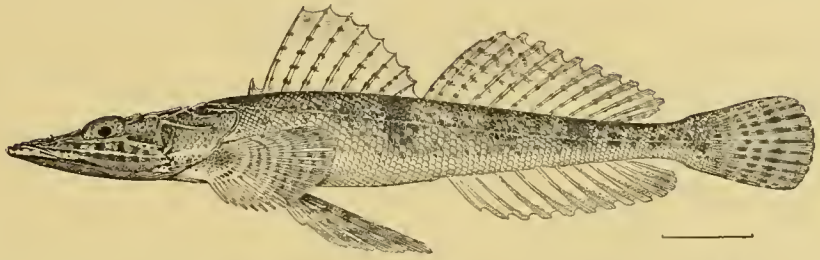


FIG. 51. *Inegocia japonica* (Tilesius). (From Proc. U. S. N. M., Vol. XXXIII, p. 637).

267. **Inegocia crocodilus** (Tilesius).

(Mem. Carn. Mus., Vol. VI, p. 54, fig. 49, as *Thysanophrys*).

Osaka, No. 6351a–l.

Family HOPLICHTHYIDÆ.

268. **Hoplichthys gilberti** Jordan & Richardson.

Misaki, No. 6078a, identical with the types.

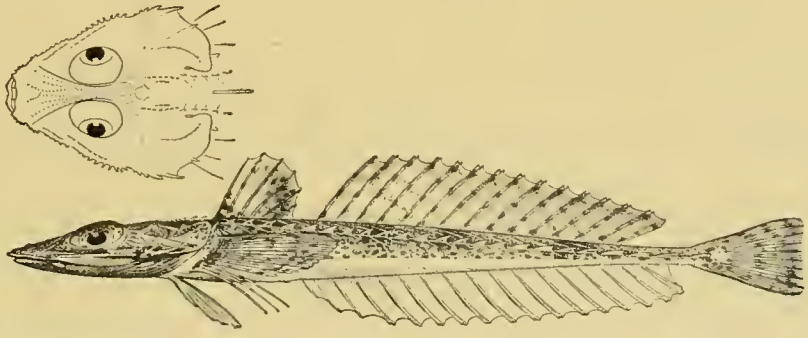


FIG. 52. *Hoplichthys gilberti* Jordan & Richardson. (From Proc. U. S. N. M., Vol. XXXIII, p. 648).

269. **Hoplichthys langsdorfi** Cuvier & Valenciennes.

Yawatahama, in Iyo; Misaki, No. 6017a.

We have elsewhere stated that this is not the *Hoplichthys langsdorfi* of Jordan & Richardson, which is a third species, *Hoplichthys regani* Jordan. These specimens agree with the plate of *H. langsdorfi* of Cuvier & Valenciennes, except that the number of anal rays is seventeen. *H. langsdorfi* differs from the other two species in having two well-developed spines on each body-scute, instead of one, as in *H. gilberti*, *H. regani*, and the Hawaiian species, *H. citrinus*.

Scutes 27; D. VI.–15; A. 17. Eye 4.5 in head, pectoral appendages not reaching tip of pectoral by 1.25 diameter of eye. Height of spinous dorsal 3.66 in head.

Family BEMBRIDÆ.

270. **Bembras japonicus** Cuvier & Valenciennes.

Nagasaki, one example, No. 4167a.

Family AGONIDÆ.

271. **Tilesina gibbosa** Schmidt. (Plate XXXIII, fig. 1).

Hokkaido, Japan, No. 6022a–f. An adult and a number of young.

This species is described in Russian in Schmidt's *Pisces Marium Orientalium* and beautifully figured. In order to provide a description for those unable to read Russian our adult specimen is here described, length 29 cm.

Head 4.5 in body without caudal, 5.2 in total length; depth 2.33 in head; D. XVIII–9; A. 26; P. 15; V. I, 2; body-plates 51, transverse 5; eye 5.5 in head; snout 3; maxillary 3.66; interorbital space 8; breadth at opercles 2.

Head conical; snout somewhat elongate; lower jaw strongly projecting; maxillary just failing to reach anterior border of eye; pre-orbital swollen, where it covers maxillary; each plate on sides of head and temporal region with a blunt apex or a sharp spine, those on opercles and cheek highest; a rough ridge forming upper posterior border of eye; each plate of body with a posteriorly directed sharp spine, rows converging on breast, with blunter spines in this region; lateral line with a small series of spinate plates half the breadth of those above them; three plates on base of pectoral; line of back between occiput and dorsal with small spinules in an irregular row, belly similar in posterior half; anterior half of median line of belly soft, not armed; anus midway between insertion of anal and isthmus.

Spinous dorsal inserted over seventh body-plate; first spine highest, 1.75 in head, last adnate to back; insertion of second dorsal three plates posterior to tip of last spine, over thirty-second body-plate, first ray 2.5 in head; caudal 1.66 in head; anal inserted opposite sixteenth body-plate, its termination two plates posterior to that of soft dorsal; pectoral reaching insertion, first ten rays of nearly equal length; ventrals under pectoral base, reaching half-way to anal.

Color nearly uniform on body, a narrow dark stripe through eye from snout, continued as a row of spots along lateral line, more distant posteriorly; two upper pectoral rays dark, two indistinct transverse rows of spots in upper half of pectoral; dorsal, anal, and caudal uniformly dark-hued, nearly black.

272. **Brachyopsis rostratus** (Tilesius). (Plate XXXIII, fig. 2).

Taruku Island, Nemuro, Hokkaido, No. 6032 (Coll. Owston).

This agrees with specimens from the Kuriles. D. varying from VII–8 to IX–8. Body-plates 45.

Family CYCLOGASTERIDÆ.

273. **Cyclogaster tanakæ** Gilbert & Burke.

Three large specimens, No. 6350a–c, from Aomori, the two smaller lacking "thumb-tack" prickles; two from Misaki, No. 6355a–b, and two from Oshima, with prickles well developed. The longest is three hundred and seventy-five millimeters in total length.

274. **Cyclogaster Agassizii** (Putnam).

Hokkaido, No. 6301a (Coll. Owston).

D. 42; A. 34; P. 36.

275. **Cyclogaster frenatum** Gilbert & Burke.

Misaki, No. 6093a (Coll. Owston).

One example 90 cm. long, differing from the type in having the vertical fins largely black; otherwise the same.

276. **Careproctus burkei** sp. nov. (Plate XXXIV, figs. 2 and 2a).

Described from the type, No. 6457, Carnegie Museum Catalog of Fishes, a female 92 mm. in total length, and a female cotype, 83 mm. long, both from Yokohama Market, doubtless from outside the heads of Awa and Boshu. The measurements are given in hundredths of body-length to base of caudal, those of the cotype in parenthesis.

Length of head .245 (.235); depth .25; width of head .20; eye .05; snout .75; maxillary .07 (.08); longitudinal diameter of disk .10; distance snout to disk .15 (.13); disk to vent .18 (.14); snout to vent .40 (.35); depth of caudal peduncle .04; length of upper pectoral lobe .16; of lower pectoral lobe .125; gill-slit .07; interocular space .075; distance vent to insertion of anal .135; snout to dorsal .30; D. 37; A. 30; C. 14; P. 33.

Body deep, not quite as wide as deep at opercle; tail strongly compressed; mouth nearly transverse; tip of maxillary not reaching eye; snout slightly overhanging premaxillaries, rounded in profile; nostrils tubular, without flap, situated at level of pupil; teeth simple, in broad bands, blunt. Gill-opening not extending below first pectoral ray, set somewhat obliquely.

Dorsal not notched, first rays low, increasing in height until middle of fin; anal similar; dorsal and anal joined to caudal by its basal third, last rays not shortened in either; pectoral notch shallow, lower lobe extending just beyond posterior margin of disk, its rays but half an eye-diameter longer than those of notch.

Color in alcohol reddish; distal half of pectoral dusky; dorsal and anal somewhat darker than pectoral, anal much more deeply colored than dorsal; caudal dusky, peritoneum colorless, as is buccal cavity.

Named for Dr. Charles Victor Burke who has specially studied the Cyclogasteridæ.

277. **Careproctus gilberti** sp. nov. (Plate XXXIV, figs. 7 & 7a).

Described from the type, No. 6456, a specimen much shrunken by strong alcohol, from Misaki, Sagami Bay, Japan, 16 cm. in total length. The measurements are given in hundredths of body-length to correspond with the comprehensive paper recently published by Gilbert and Burke on the Japanese *Cyclogasteridæ.*

Head .25; width of same .17; interocular width .10; width at angles of mouth .12; length of snout .09; eye .06; maxillary .12; width of gill-slit .06; depth of body .19; distance from snout to disk .19; from snout to anus .34; snout to anal fin .42; snout to dorsal insertion .28; transverse diameter of disk .08; distance disk to anus 7; longest ray in upper pectoral lobe 17, in lower 12. D. 45; A. 38; P. 32.

Body elongate, compressed; head deeper than wide; dorsal profile most strongly curved on snout; jaws subequal; maxillary extending to below anterior border of pupil; eyes high, reaching dorsal profile as in *Careproctus curilanus;* nostril at level of upper edge of pupil; teeth coarse, in bands in both jaws, simple, not trilobed, depressible. Gill-opening extending to second pectoral ray. Pectorals not deeply notched, rays of lower lobe slightly produced as filaments. Anterior dorsal rays half length of posterior rays, latter .10 of body-length; former with tips slightly produced; first anal rays .07, last .10; dorsal and anal adnate to caudal by one-fourth its length, last ray in each slightly shorter than preceding rays. Disk beginning under, or slightly behind, posterior margin of eye and reaching to below point of opercle, separated by its own transverse diameter from anus, which resembles that of *Careproctus pycnosoma* in position.

Color faded or lacking. Peritoneum jet-black.

This is named for Dr. Charles Henry Gilbert.

Family TRIGLIDÆ.

278. **Chelidonichthys kumu** (Lesson & Carnot).

Osaka, No. 6325a–b; Misaki, No. 6282a–c; Misaki, No. 6282a–c; Matsushima

279. **Chelidonichthys ischyrus** sp. nov. (Plate XXXV, fig. 1).

Described from the type, No. 6459 Carnegie Museum Catalog of Fishes, a specimen one hundred and fifty millimeters in total length, coming from Sagami Bay, Japan, and collected by Mr. Alan Owston.

Head 2.5 in body-length to base of caudal; depth 3.66; eye 3.66 in head; snout 2.166; interorbital space two-thirds of eye; dorsal rays X–16 (last spine rudimentary); anal rays 15; scales 67 in lateral line, 8/5 in transverse series; gill-rakers 1+10.

Body subcylindrical, deep, and relatively shorter than in *Chelidonichthys kumu;* snout with two low lobes, each with four very short spines or serrations; maxillary reaching to anterior border of orbit. Two prominent preocular spines, and one blunt postocular present; a prominent transverse furrow behind the latter. Nuchal region rough.

Dorsal inserted between tips of nuchal spines; third spine 2 in head; third ray 2.66; first anal rays 3.33 in head; pectoral 1.9 in body length, reaching to base of last ray; ventrals extending to fifth anal ray; upper pectoral appendage 3.33 in body.

Scales minute, imbricate, but partially imbedded, those of lateral line slightly enlarged; shields along dorsals twenty-five in number, their edges smooth throughout, spinous projections well-marked and sharp.

Color of alcoholic specimens dark, without silvery reflections; an indefinite dark space between orbit and corner of mouth, also on lower edge of opercle; two dark spots below spinous dorsal opposite third and tenth scutes and one on lateral line, one opposite sixteenth dorsal scute, and at end of dorsal, an indefinite one below each on lateral line. Spinous dorsal black on distal half; soft dorsal colorless; pectorals black inside; ventrals tipped with dark; caudal dusky at tip; anal clear.

This species differs from *Chelidonichthys kumu* in its larger scales, larger eye, larger head, and extent of pectoral. Its scales are much smaller than those of *Lepidotrigla.* From *L. japonica,* which it resembles, it may be easily distinguished by the scales, by the lesser depth of the postocular furrow, and shorter nasal processes.

280. **Lepidotrigla alata** (Houttuyn).

Misaki, No. 6099a.

281. **Lepidotrigla güntheri** Hilgendorf.

Misaki, No. 6242a–b; Osaka, 6379a–e.

282. **Lepidotrigla strauchii** Steindachner.

Lepidotrigla microptera Jordan & Richardson, not of Günther, which is a Chinese species.

Osaka, from Matsushima Bay, No. 6328a–b; Sendai, No. 6305a; Sagami Bay; Misaki, No. 6434a–e.

Spinous dorsal blotch present in young.

283. **Lepidotrigla japonica** (Bleeker). (See Fig. 53, p. 284).

Misaki, No. 6270a–l.

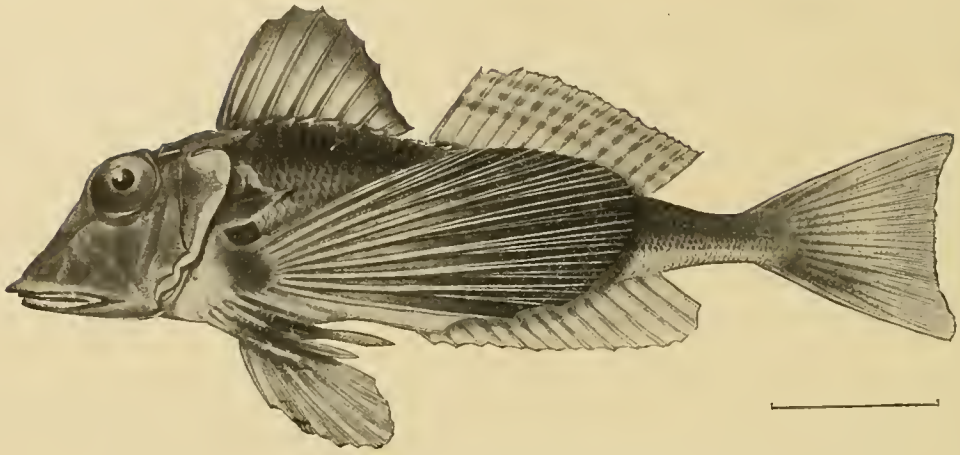


Fig. 53. *Lepidotrigla japonica* (Bleeker). (From Bull. U. S. Fish Comm., Vol. XXIII, p. 596).

284. **Lepidotrigla abyssalis** Jordan & Starks.

Tsushima Straits, obtained in the Osaka Market, No. 6262a–g.

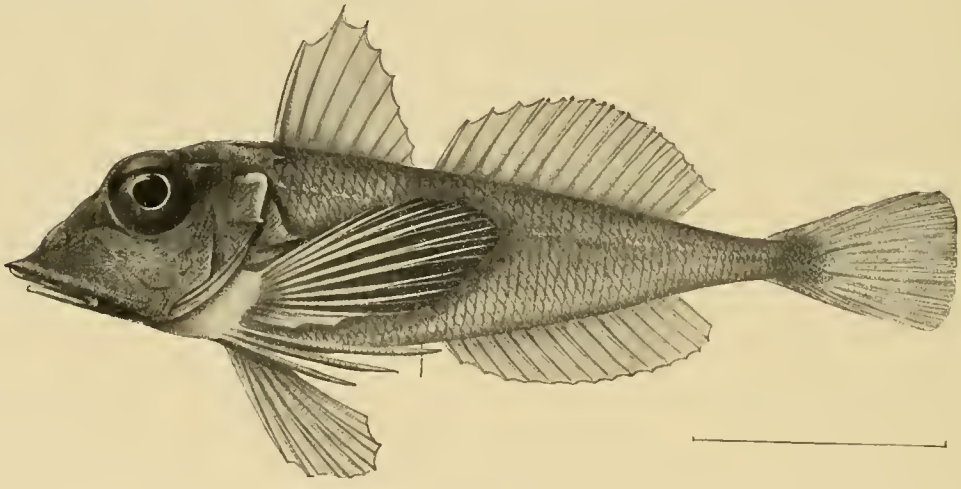


Fig. 54. *Lepidotrigla abyssalis* Jordan & Starks. (From Bull. U. S. Fish Comm., Vol. XXII, p. 595).

Some specimens have a red spot on the dorsal, placed as the black spot in other species. Serrations of second dorsal spine variable.

Family PERISTEDIIDÆ.

285. **Peristedion orientale** Temminck & Schlegel. (See Fig. 55, p. 285).

Misaki, No. 6300a–c.

Family CEPHALACANTHIDÆ.

286. **Dactyloptena orientalis** (Cuvier & Valenciennes).

Sodokatsu, Yokohama, No. 6307a, Misaki, No. 6100a.

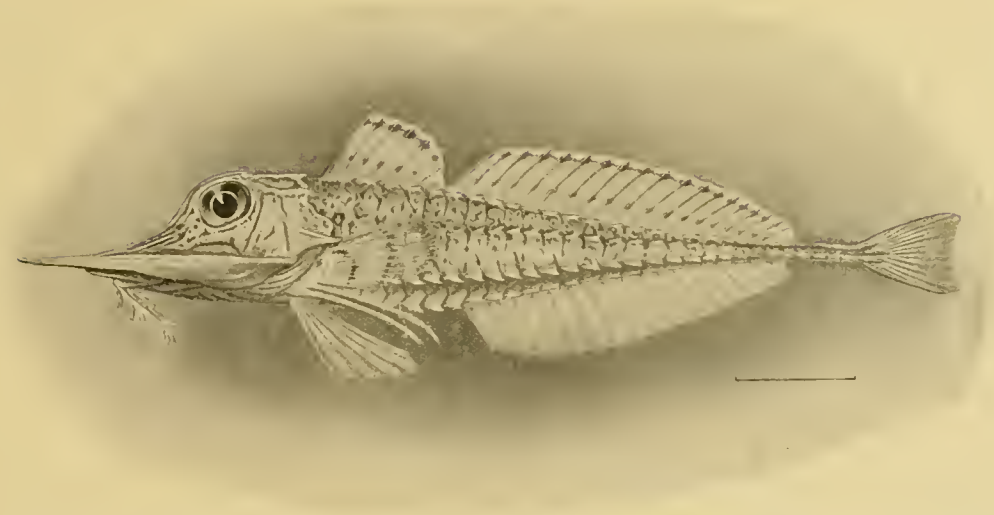


FIG. 55. *Peristedion orientale* Temminck & Schlegel. (From Bull. U. S. Fish Comm., Vol. XXII, p. 593).

We have before us a young example of *Dactyloptena orientalis* (No. 6307a) sixty-eight millimeters long, with a black spot on pectoral as in *D. cheirophthalmus* (Bleeker).

One small specimen, fifty-six millimeters in total length, from Misaki, (No. 6100a) is with slight hesitation identified as *D. orientalis*, because of the very much greater proportionate length of the head and spines, large eye, and long dorsal spine. An examination of a series of individuals shows that in this species this is a character of the young. The following table illustrates the changes with age and the peculiarities of the specimen before us. The fin and scale-counts are typical.

	Hilo, Hawaii.	Queens-land, Australia.	Wakanoura, Kii, Japan.				Misaki, Japan.
Length[6]	215 mm.	148	122	115	95	82	56
Head	24	25	26	25	26	28	32
Snout to tip of scapular spine	37	38	38	39	41	43	52
Eye	8.5	9.0	8.5	9.0	10.0	11.0	14.0
Pectoral	95	87	90	92	84	91	81
Dorsal spine	35	33	35	36	36	37	44
Interorbital space	13	13	14	13.5	15	16	19
Distance from snout to occiput	20	21	20	21	22	24	82

By Jordan and Richardson[7] it is stated that *Dactyloptena orientalis* lacks a lateral line, but a close examination shows its presence in fully functional condition with developed tube and pores. The distinction raised between this genus and

[6] Body-length, to base of caudal, in terms of hundredths of which the other measurements are given.

[7] Proc. U. S. N. Mus., Vol. XXXIII, p. 664, 1908.

Ebisinus Jordan and Richardson, does not exist, and *Ebisinus cheirophthalmus* (Bleeker) is generically identical with *Dactyloptena orientalis* (Cuvier and Valenciennes), and *D. gilberti* Snyder. The statement made by the same authors as to the absence of the lateral line in *Cephalacanthus*, *Dactyloptena*, and *Daicocus* is incorrect, as the pores are invariably present, although obscured by great development of the scale process which lies at right angles to the keel, and slightly oblique to the surface of the body. It is very indistinct in *Cephalacanthus*, but by clearing a piece of the skin in glycerin and observing it under the microscope the presence of pores is easily demonstrated in all these forms.

Family GOBIIDÆ.

287. **Eviota abax** (Jordan & Snyder).

Misaki, No. 6413a–j, numerous specimens.

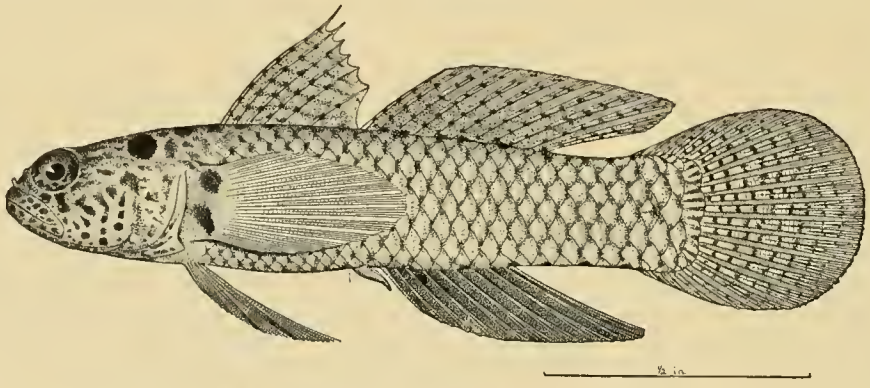


Fig. 56. *Eviota abax* (Jordan & Snyder). (From Proc. U. S. N. M., Vol. XXIV, p. 40).

As compared with the types, the males have the first spine of the dorsal much elongated, reaching fourth or fifth ray of second dorsal; ventrals nearly black, with a white margin; anal much darker; scale-markings much more decided.

288. **Odontobutis obscurus** (Temminck and Schlegel).

Lake Biwa, at Matsubara, No. 6243a–l; Okayama, No. 6429a–b.

The reference of this species to the East Indian genus *Mogurnda* is premature.

289. **Periophthalmus cantonensis** (Osbeck).

Nagoya, No. 6054a.

290. **Ctenogobius similis** (Gill).

(Mem. Carn. Mus., Vol. VI, Plate X, fig. 3).

Lake Biwa at Matsubara, No. 6079a–d.

291. **Ctenogobius virgatulus** Jordan & Snyder.

Kobe, No. 6092a (Coll. Manabe); Misaki, 6126 many.

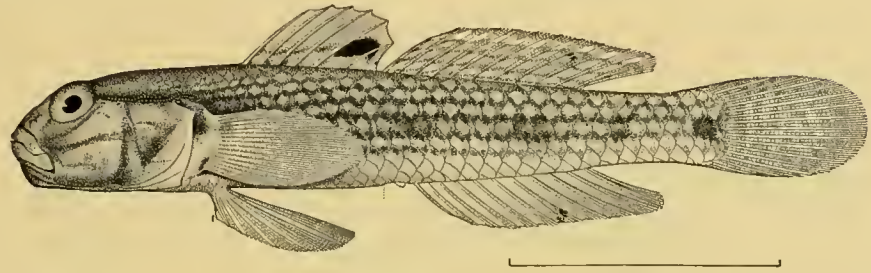


Fig. 57. *Ctebogobius virgatulus* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 64).

292. **Ctenogobius pflaumi** (Bleeker).

Misaki, No. 6123a.

293. **Ctenogobius atriceps** Regan.

Nagoya, No. 6133a–d (Coll. Kingsbury).

D. VI–12; A. 11. Scales 36–14. Last dorsal rays not quite reaching caudal. This species, which is near *C. similis*, has been known hitherto only from the type, which came from Kobe.

294. **Mugilogobius abei** (Jordan & Snyder).

Nagoya, No. 6135a, Shimbara.

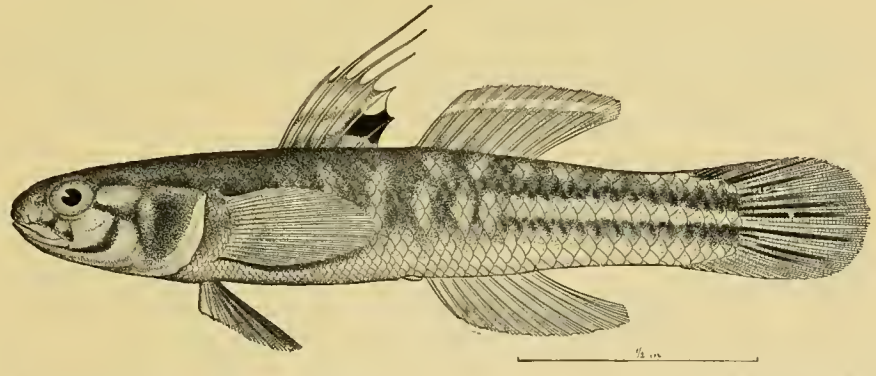


Fig. 58. *Mugilogobius abei* (Jordan and Snyder). (From Proc. U. S. N. M., Vol. XXIV, p. 55).

This species is the type of Smitt's genus *Mugilogobius*, which seems to be the same as *Vaimosa* of Jordan & Seale.

295. **Aboma snyderi** Jordan & Fowler.

Nagoya, No. 6124a–c.

Head 3.33; depth 5.33; scales 53. D. VIII–14; A. 12. Opercle partly scaled above. In the original types as figured, the color, being faded, is not well shown.

Each dorsal spine has four spots, making four parallel lines, save on the last three spines, which have two larger spots. Four lines on the soft dorsal are parallel with the line of the back.

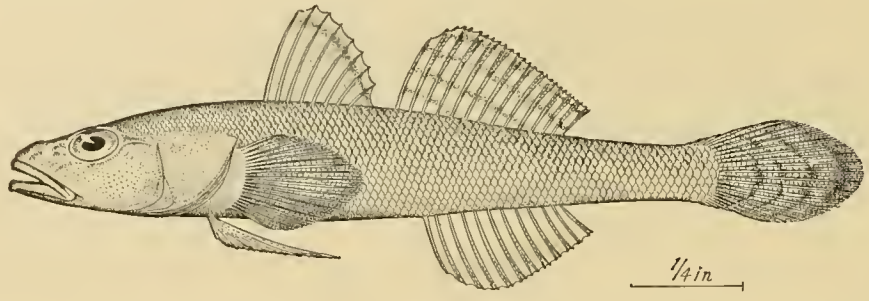


Fig. 59. *Aboma snyderi* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXV, p. 575).

296. **Cryptocentrus filifer** (Cuvier & Valenciennes).
Kobe, No. 6089a (Coll. Manabe).

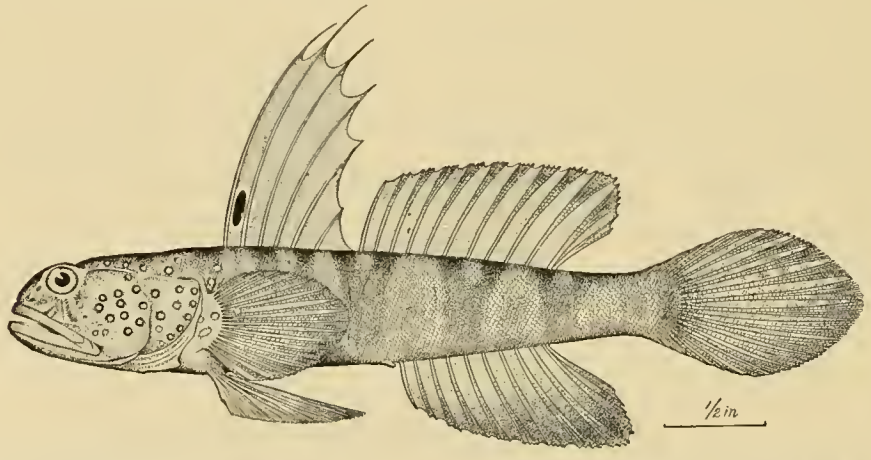


Fig. 60. *Cryptocentrus filifer* (Cuvier & Valenciennes). (From Proc. U. S. N. M., Vol. XXIV, p. 73).

297. **Glossogobius brunneus** (Temminck & Schlegel).
Nagoya, No. 6062a; Kobe, No. 6431a (Coll. Manabe).

298. **Chænogobius macrognathus** (Bleeker).
(Mem. Carn. Mus., Vol. VI, p. 56, fig. 53).
A. Misaki, 6104a–b, 6426 a–i.
No dark blotch on first dorsal; sides without spots; cheeks finely and evenly punctate with small brown dots. Caudal peduncle 2 in head.
B. Yokohama.
D. VI–13; A. 11. Scales 73.

299. **Chloea sarchynnis** Jordan & Snyder.
(Mem. Carn. Mus., Vol. VI, p. 56, fig. 53).
Misaki, No. 6129a.

300. **Chasmichthys gulosus** (Sauvage).
(*Saccostoma gulosus* Sauvage; *Chasmias misakius* Jordan & Snyder).
(Mem. Carn. Mus., Vol. VI, Pl. X, fig. 2).
Kobe, No. 6403a–b (Coll. Manabe); Goto Islands (Owston); Misaki, No. 6313 many.

301. **Chasmichthys dolichognathus** (Hilgendorf).
(Mem. Carn. Mus., Vol. VI, p. 56, fig. 55).
Misaki, No. 6255 many.

302. **Pterogobius daimio** Jordan and Snyder.
Misaki, No. 6107a–d.
As elsewhere stated, there are both males and females among the specimens referred to this species. It is not therefore the male of *Pterogobius elapoides.*
The latter species ranges farther to the northward. It is less brightly colored, and has one more cross-bar at the base of the caudal.

303. **Pterogobius elapoides** (Günther).
(Mem. Carn. Mus., Vol. VI, p. 56, fig. 54).
Misaki, Iyo.

304. **Pterogobius zacalles** Jordan & Snyder.
Misaki, No. 6233a.

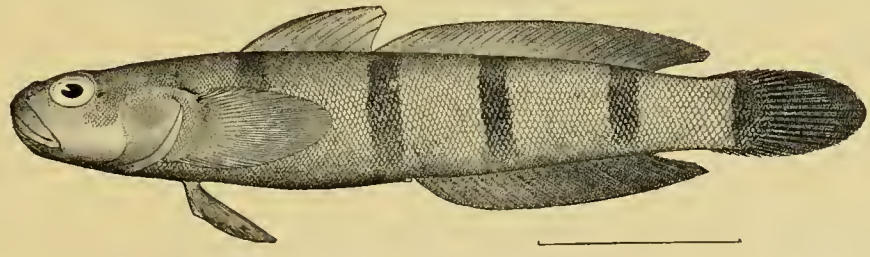


FIG. 61. *Pterogobius zacalles* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 94).

Larger than the types, one hundred and fifty-five millimeters.

305. **Acanthogobius flavimanus** (Temminck & Schlegel).
Shimonoseki, No. 6201a; Osaka, No. 6256a–f; Kobe, No. 6213a–b (Coll. Manabe); Misaki, No. 6095a; Matsushima, No. 6261a; Nagoya, No. 6445a–h.

306. **Parachæturichthys polynemus** (Bleeker).
Shimonoseki, No. 6071a.

307. **Chæturichthys sciistius** Jordan & Snyder.
Shinabara, No. 6041a, No. 4257a.

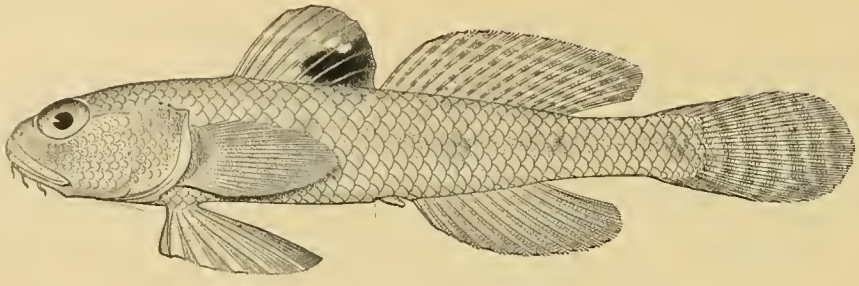


Fig. 62. *Chæturichthys sciistius* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 108).

308. **Chæturichthys hexanemus** Bleeker.
Kobe, No. 6111a; Shimonoseki, No. 6159a–g.

309. **Aionosus geneionemus** (Hilgendorf). (Plate XXXV, fig. 2).
Misaki, No. 6005.
The largest specimen is ninety millimeters long. This example we figure.
The maxillary reaches anterior edge of pupil; membrane of first and second, dorsal spine with a dark blotch on its distal half. A dark spot at base of caudal.

310. **Doryptena tanegashimæ** Snyder.
One specimen from Yawatahama, Iyo.

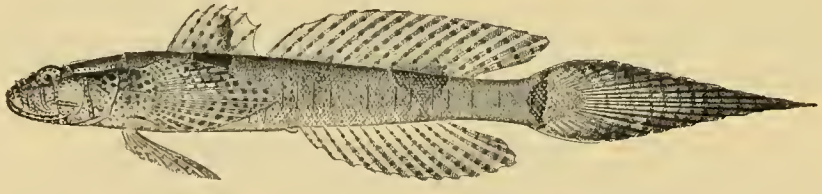


Fig. 63. *Doryptena tanegashimæ* Snyder. (From Proc. U. S. N. M., Vol. XLII, Pl. 59, fig. 2).

Dorsals more darkly colored, otherwise like Snyder's types.

311. **Tridentiger obscurus** (Temminck & Schlegel).
Misaki, No. 6053a.

312. **Tridentiger bifasciatus** Steindachner.
(Mem. Carn. Mus., Vol. VI., p. 56, fig. 58).
Nagoya, No. 6130.

313. **Sicyopterus japonicus** (Tanaka). (Plate XXXV, fig. 3).
Misaki, No. 6427a–h; Hiyuga in Kiusiu.
Numerous specimens, the longest, one hundred and twenty-five millimeters, figured in Plate XXXV.

Schlegel's *Sicydium obscurum* is probably the same as *Tridentiger squamistrigatus* of Hilgendorf, with which Jordan and Snyder have identified it. The description fits the *Sicyopterus* almost equally well, and the drawing diverges from both.

314. **Clariger cosmurus** Jordan & Snyder.

Misaki, No. 6075a–b.

A double row of papillæ below eye, continuous anteriorly with a row along upper orbital edge. Two sharp dermal ridges extending posteriorly from tip of snout as far as eye. Double serrated folds diverging from tip of lower jaw. Nasal tubules prominent. Two pairs of longitudinally set dermal flaps on tip of lower

FIG. 64. *Clariger cosmurus* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 121).

jaw, one behind the other, these not true barbels, but parts of the dermal folds. Median line of body with about twenty-five pores. Scales in four or five rows on caudal peduncle, one row extending forward to middle of dorsal. Second and third dorsal spines wide-set.

This rare species is one of the most peculiar among the gobies. Its color-pattern is variable, the opposed saddles on caudal peduncle very shallow in young; lateral stripes along body much narrowed; caudal nearly plain dark; eight spots along upper edge of stripes in one adult, in the other represented by a ragged edge; white areas coarsely punctate, with small brown dots.

315. **Leucopsarion petersi** Hilgendorf.

Kobe, No. 6068a–b (Coll. Manabe).

FIG. 65. *Leucopsarion petersi* Hilgendorf. (From Proc. U. S. N. M., Vol. XXIV, p. 126).

316. **Luciogobus elongatus** Regan. (See Fig. 66, p. 292).

Misaki, No. 6052a; Lake Biwa, No. 6226a–g.

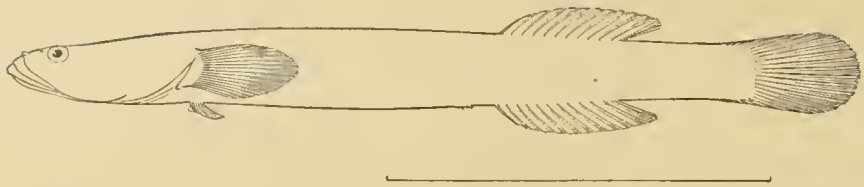


FIG. 66. *Luciogobius elongatus* Regan. (From Proc. U. S. N. M., Vol. XXIV, p. 124).

This elongate form, as noted by Jordan and Snyder, seems scarcely different from *Luciogobius guttatus*. It is slenderer, has a slightly longer mouth, and a paler color than the latter.

317. **Trypauchen wakæ** Jordan & Snyder.
Kobe, No. 6234a–b (Coll. Manabe).

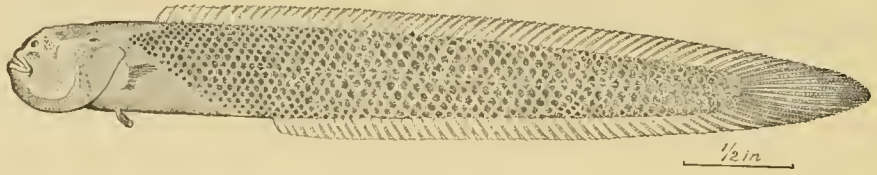


FIG. 67. *Trypauchen wakæ* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 127).

Family CHAMPSODONTIDÆ.

318. **Champsodon vorax** Günther.
Misaki, No. 6108a; Iyo.

Family PTEROPSARIDÆ.

319. **Parapercis pulchella** (Temminck & Schlegel).
Misaki, No. 6432a.

320. **Parapercis ommatura** Jordan & Snyder.
Kobe, No. 6113a–b (Coll. Manabe).

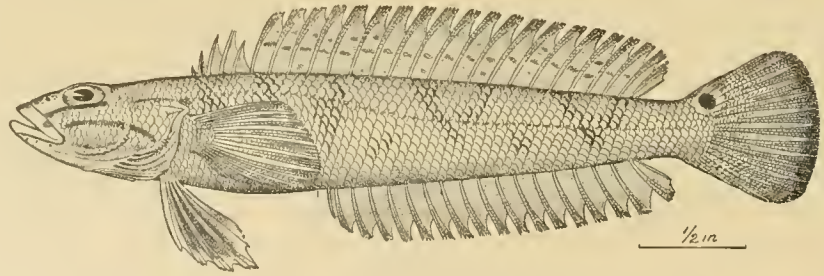


FIG. 68. *Parapercis ommatura* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 465).

321. **Neopercis multifasciata** (Döderlein).
Misaki, No. 6246a.

Agreeing well with Döderlein's account. There are eleven black cross-bars and a dark blotch.

322. **Neopercis sexfasciata** (Temminck & Schlegel).
Shimonoseki, No. 6217a.

Family OPISTHOGNATHIDÆ.

323. **Owstonia totomiensis** Tanaka.
Coll. Owston. Totomi Bay (original cotypes).
This remarkable fish is apparently an ally of *Opisthognathus* and *Gnathypops*.

324. **Gnathypops iyonis** Jordan & Thomspon.
Yawatahama, in Iyo; Kiusiu (Coll. Manabe).

Family URANOSCOPIDÆ.

325. **Uranoscopus japonicus** Houttuyn.
Misaki, No. 6279a; Osaka, No. 6265a–c.

326. **Uranoscopus oligolepis** Bleeker.
Misaki, No. 6319a–b (Coll. Aoki).
Lower jaw broader in front than in *U. japonicus*, and with a prominent fringe; head rougher; eyes much closer to premaxillary; pectoral much longer; ventrals longer. Caudal not dusky.

327. **Ichthyscopus lebeck** (Schneider).
Osaka, No. 6364a.

328. **Ariscopus iburius** Jordan & Snyder.
Kobe, No. 6084a (Coll. Manabe).

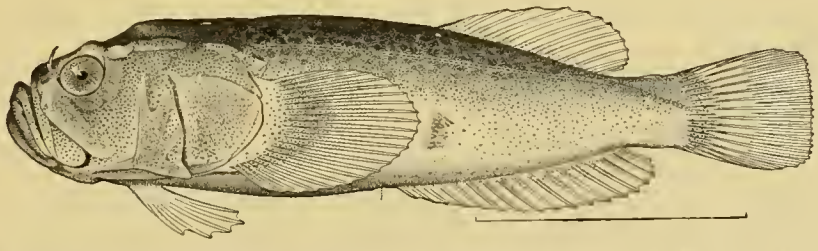


Fig. 69. *Ariscopus iburius* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXIV, p. 479).

Hitherto known only from Iburi in the Hokkaido, in the north of Japan.

Family CALLIONYMIDÆ.

329. **Callionymus valenciennesi** Temminck & Schlegel.
(Mem. Carn. Mus., Vol. VI, p. 59, fig. 59).

Misaki, No. 6190a–b; Shimonoseki, No. 6299a; The longest specimen is 10.5 inches in length.

330. **Callionymus lunatus** Temminck & Schlegel.

Misaki, No. 6443a.

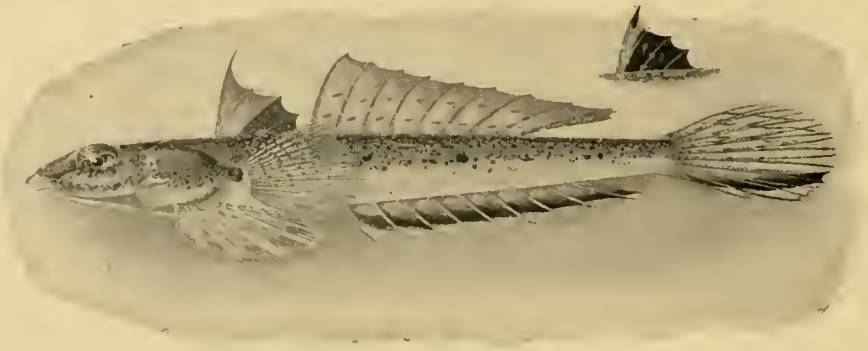


Fig. 70. *Callionymus lunatus* Temminck & Schlegel. (From Proc. U. S. N. M., Vol. XXV, p. 949).

331. **Calliurichthys japonicus** (Houttuyn).

Misaki, No. 6285a–d.

Preopercular spine on one side, with two hooks, but typical on the other.

Fig. 71. *Calliurichthys japonicus* (Houttuyn). (From Proc. U. S. N. M., Vol. XXV, p. 942).

332. **Calliurichthys doryssus** Jordan & Fowler.

Misaki, No. 6402a–c (Coll. Aoki).

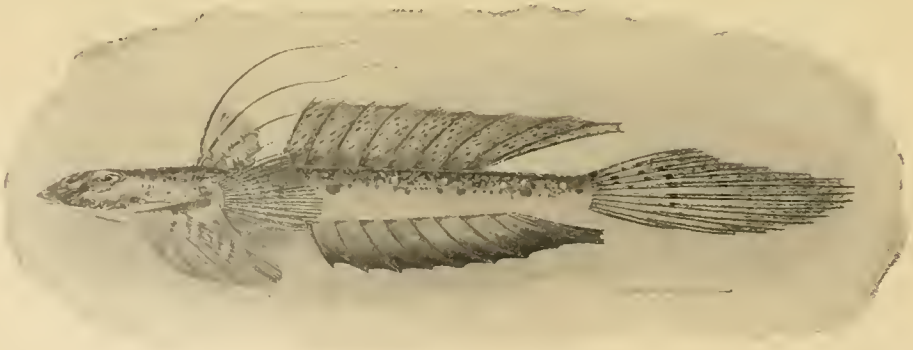


Fig. 72. *Calliurichthys doryssus* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXV, p. 946).

333. **Synchiropus ijimæ** sp. nov. (Plate XXXVI, fig. 1).

The type described, No. 6015a Carnegie Museum Cat. of Fishes, is a specimen which came from Misaki and is sixty-five millimeters in total length.

Head 3.16 in length to base of caudal; depth 5; eye 4 in head; snout 3.66; width of body at opercles 1.5 in head, 1.16 times in depth; D. IV–8; A. 7; P. 18; V I–5; eighteen or twenty pores in lateral line.

Body but little depressed, nearly as deep as wide at head, more so posteriorly; its form quite unlike that of the Japanese species of *Callionymus;* eyes large, obliquely set, projecting above profile of head; bone of interorbital space very narrow, 3.33 in pupil of eye; suborbital space 6.5 in head; maxillary reaching anterior edge of eye; pre-opercular spine with two hooks, one at its tip, and another, as strong above; gill-opening circular, small, at upper angle of opercle; latter with a loose, fold of skin below forming a flap-like lower edge above ventrals, this not free at tip of opercle; teeth of both narrow jaws anteriorly in broad bands, which posteriorly diminish in breadth.

Insertion of spinous dorsal over point of pre-opercular spine; all its rays filiform, membrane extending along three-fifths of first spine, one-half of third spine and two-fifths of fourth spine; first spine slightly longer than head, second somewhat longer, 2.5 in head; second dorsal of equal height save for last somewhat elongate rays; anterior rays 1.6 in head; last ray reaching to base of upper rudimentary caudal rays, as does last of anal; caudal rounded; anal rays 2 in head, insertion below first and second rays of soft dorsal; pectoral reaching beyond anal insertion; ventrals of like extent, their bases in large part anterior to those of pectorals; membrane from inner ray attached to middle of pectoral base.

Color in alcohol light, with brown spots arranged across body in seven bands as wide as eye, these bands tending to coalesce extensively on lower side of flanks before being lost in colorless lower surface of body; cheeks and suborbitals with similar or slightly smaller brown spots more clearly defined than those of body; a brown blotch as large as pupil below pre-opercular spine; spinous dorsal with narrow sinuous streaks and shadings of brown; soft dorsal broadly banded with brown; bands running downward and backward to base of fin as they pass backward; membrane between last rays dark brown; caudal with four or five cross-bands, plainest on upper and lower rays; pectoral with five or six brown cross-bands; ventrals with inner rays dark brown at tip; body indefinitely clouded elsewhere, with a number of small clear spots on membrane connecting with mid-pectoral base; anal rays tipped with white, their membranes darkened in margin.

This species is named for Mr. Isao Ijima, Professor of Zoölogy in the Imperial University of Tokyo.

We refer it with some doubt to the genus *Synchiropus* Gill. It is very close to *Synchiropus lili* described by Jordan and Seale from Samoa, but it may not be congeric with *Synchiropus opercularis*, the type of the genus. Except for the compressed head, the species are very much like *Callionymus*.

334. **Calymmichthys xenicus** gen. et sp. nov. (Plate XXXVI, fig. 2).

We give description of the type, No. 6027, Carnegie Museum Catalog of Fishes, one hundred and thirty-five millimeters in total length, which came from Sagami Bay.

Head 3.5 in body-length to base of caudal; depth 7.5; eye 5 in head (including opercular flap); snout 3; interorbital space 5 in snout; maxillary 3.2 in head; D. IV–8; A. 7; C. 11; P. 19; twenty-two pores in lateral line.

Body cylindrical, tapering evenly to caudal; breadth of depressed head behind pre-opercular spines equal to distance from anterior border of eye to tip of opercular flap; interorbital space narrow, its width 3 in eye; snout long, straight in profile, as is dorsal surface of head; profile arched over eye; interorbital space and dorsal surface of snout flat, forming an angle with sloping sides of head and snout; maxillary of peculiar shape, its angle forming a prominent knob at angle of mouth under anterior border of eye; depth of space between snout and premaxillaries two-thirds length of eye; teeth in upper jaw in broad, villiform, semicircular patch, not extending beyond apex of arch in sides of jaw; teeth in lower jaws along whole length of mandibular rami anteriorly, of breadth and shape to correspond to those in upper jaw; vomer and palatines toothless; pre-opercular spine as long as eye, with seven spinules as long as width of spine on dorsal edge, all antrorse but last two; a strong tooth at base pointing forward; opercle with distinct free flap, as in *Synchiropus opercularis*, its tip free, its length equal to diameter of eye; gill-opening small, not as large as pupil, at upper angle of opercle; upper surface of head with slightly roughened patch on bony surface, larger than eye.

First dorsal spine elongate, 3.25 in body-length, second 7.5, last two-thirds length of second, all when supine reaching approximately base of first ray of second dorsal; first ray of latter 6.33 in body-length; last double ray elongate, 4 in body; extending to base of caudal rays; latter slightly less than length of head; tips of rays slightly exserted; first anal ray 10 in body, last 6; latter not reaching caudal; anal membranes strongly incised; pectorals 1.5 in head; ventrals 4.33; upper membrane beginning at level of fourth pectoral ray, extending beyond anal insertion.

Lateral line with long, low arch anteriorly, as long as head and two-thirds diameter of eye from dorsal base at its end. A thin but prominent fold of skin extending from pectoral tips to base of caudal, flexed upward.

Color in alcohol dark brown, five indistinct cross-bars of darker brown as wide or wider than eye on upper part of body, first under spinous dorsal second under insertion of second, last on middle of caudal peduncle; between these cross-bars indefinite reticulations of darker brown; cheeks, side of snout, and opercular membranes with narrow sinuous lines margined differently with white, five or six present on lower membrane of eye; a dark blotch above and behind pre-opercular spine; spinous dorsal without striking coloration; indefinite large whitish spots in reticulations of darker color present; soft dorsal with two rows of indefinite, fused spots throughout; one or more on first rays and two more on last; soft dorsal and upper half of caudal with three narrow lines of dark along margin; caudal with three cross-bars of dark, intervening lighter areas set with minute, oblong, sharply defined spots of brown, with lighter centers; some of these also found on last dorsal ray; anal spots uniformly dark brown; pectoral with four or five irregular rows of these spots, on basal half ocellated with white, and a distal cross-stripe of white on upper half; ventrals uniformly dark, save for occasional darker spots on basal portion.

The peculiar form of the maxillary, the fold of skin along the side of the body, the opercular flap, and many-hooked spine of the pre-opercle, distinguishes this new genus, *Calymmichthys* from all other Japanese *Callionymidæ*. The opercular flap is found in *Synchiropus opercularis* (Cuvier and Valenciennes) from India. The hooked spine is found in *Calliurichthys* but in that genus these hooks are so small as to be called serrations.

Family GOBIESOCIDÆ.

335. **Aspasma minimum** (Döderlein).

Misaki, No. 6076a.

According to Tanaka (Journ. Coll. Sci., Tokyo, XXVII; 1909, p. 25) *Aspasma laticephalum* Tanaka differs from this species in having several rows of villiform teeth. It then stands alone among Japanese species and is apparently referable rather to the European genus *Mirbella* Canestrini.

The dorsal rays in *A. minimum* are 7, the anal 6. In *A. ciconiæ* we have D. 12; A. 8. In *A. misakium*, D. 14; A. 12.

336. **Aspasma misakium** Tanaka.

Misaki, No. 6128a. Longest specimen 5.8 cm. in length.

A shade of pink still left in spirits. This species differs from *A. ciconiæ* in the lesser breadth, much smaller disk, and in the greater number of rays in the dorsal and anal fins, as well as in the character, given by Tanaka, of the shorter maxillary and coalescent vertical fins. Teeth in both jaws in one row.

Family CLINIDÆ.

337. **Enneapterygius etheostoma** (Jordan & Snyder).
Misaki, No. 6237a.

338. **Zacalles bryope** Jordan & Snyder.
Misaki, No. 6102a–h.

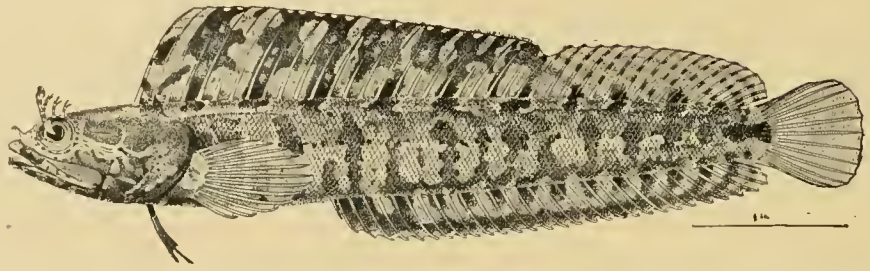


Fig. 73. *Zacalles bryope* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXV, p. 449).

Family BLENNIIDÆ.

339. **Aspidontus elegans** (Steindachner).
Misaki, No. 6229 many.

340. **Scartichthys enosimæ** Jordan & Snyder.
Misaki, No. 6416a–d.

341. **Salarias andersoni** Jordan & Starks.
Okinawa, Riu Kiu Islands, No. 6127a.

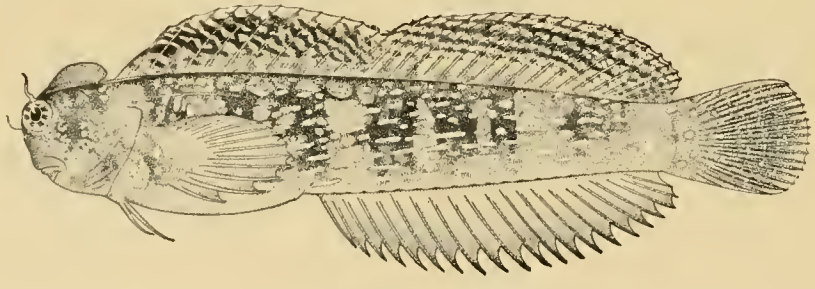


Fig. 74. *Salarias andersoni* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXX, p. 703).

Family XIPHIDIIDÆ.

342. **Bryostemma otohime** Jordan & Snyder. (See Fig. 75, p. 299).
Nanba, No. 6272a (Coll. Owston).

A very large example, two hundred and sixty millimeters long, the color pattern indistinct.

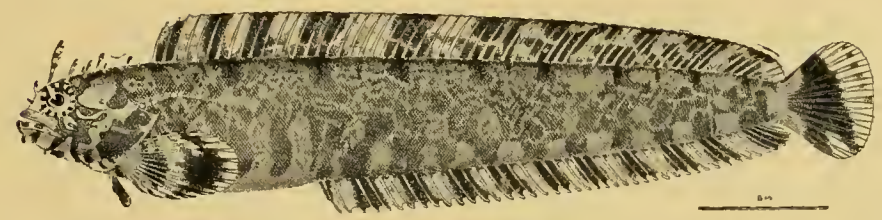


FIG. 75. *Bryostemma otohime* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXV, p. 466).

343. **Enedrias nebulosus** (Temminck & Schlegel).
(Mem. Carn. Mus., Vol. VI, p. 64, fig. 64.)
Shimonoseki, Misaki, No. 6208.

344. **Zoarchias veneficus** Jordan & Snyder.
Misaki.

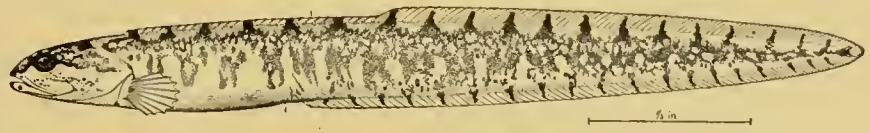


FIG. 76. *Zoarchias veneficus* Jordan & Snyder. (From Proc. U. S. N. M., Vol. XXV, p. 481).

345. **Dictyosoma burgeri** Van der Hœven.
Misaki, No. 6277 many; Goto Islands, No. 6401a (Coll. Owston).

346. **Ernogrammus hexagrammus** (Temminck & Schlegel).
Kobe, No. 6098a (Coll. Manabe).

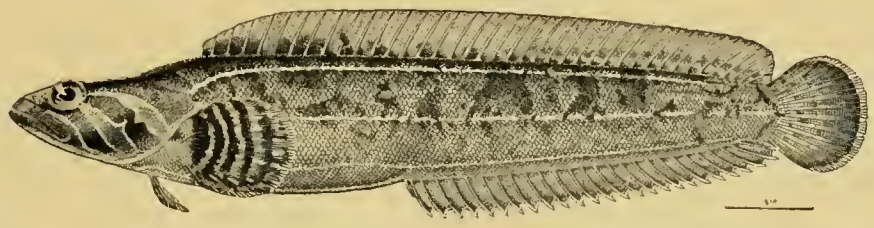


FIG. 77. *Ernogrammus hexagrammus* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXV, p. 490).

Family ATELEOPODIDÆ.

347. **Ateleopus japonicus** Bleeker. (Plate XXXVII, fig. 1).
Misaki, No. 6389a–b; Sagami Bay, No. 6001a–b.
The longest specimen is sixty-five centimeters in length. The anal varies in depth of color.

Family LYCODIDÆ.

348. **Zoarces elongatus** Kner.
Tretiapodi, Saghalin, No. 6330a–c (Coll. Owston).

349. **Lycodes tanakæ** sp. nov. (Plate XXXVII, fig. 2).

The type is a specimen four hundred and sixty millimeters in total length, from Noto, in Hondo, Japan, No. 6004 Carnegie Museum Catalog of Fishes.

Head 4.4 in length; depth 8.75 (2 in head); maxillary 2.6 in head; eye 8; snout 3.5; pectoral 1.6; ventral 1.33 in eye; D. 97; A. 76; P. 20; V. 3.

Lower jaw included, teeth of upper exposed; maxillary ending under center of eye; snout vertical at tip; skin of maxillaries continued as a prominent flap forward half the length of mandible; free inner edge of mandibular rami produced as flaps of greatest height (1.66 in eye) anteriorly, forming there a right-angled projection immediately below symphysis of lower jaw; teeth in upper jaw extending but half distance from snout to end of maxillary, in a single row, coarse and large, slightly hooked; teeth in lower jaw closing between those of upper jaw and palatines; a single series posteriorly, large and strong, most so at middle of lower jaw, where it is replaced by two well-separated rows of much smaller teeth; palatine teeth similar to those in upper jaw; in a single row on each side; vomer with two larger and stronger canine teeth pointing backwards. Anus half diameter of eye further from flap of opercle than is tip of snout.

Dorsal inserted over middle of pectoral, nearly the length of the snout behind the upper angles of the gill-openings, its longest rays posteriorly, where they are half again as long as anteriorly; dorsal and anal united and continuous with caudal; anal similar to dorsal, its insertion under the twenty-fourth ray of dorsal; length of pectoral 1.5 in head; ventrals 1.33 in eye.

Scales scattered sparsely over tail and sides of body as far forward as diameter of eye in front of dorsal insertion; none on head, belly, or pectorals; dorsal and anal scaled posteriorly nearly to margin, anteriorly more and more in base alone until the first rays are scaleless.

Color in general formed by brown reticulations around vague white blotches, latter best developed near base of dorsal, on its lower half and on dorsal surface of head, brown, becoming nearly uniform on flanks; belly white, as is ventral surface of head; dorsal and anal margined with brownish black, narrowly anteriorly, but so broad posteriorly and on caudal as to color half of fins; frequently a white oblique streak interrupting the marginal color; twelve or thirteen of these on dorsal, arranged in pairs; one or two on anal; pectorals margined with dusky, with a colorless edge.

This species is very near *Lycodes palearis* and *L. brevipes*. In color it resembles to some degree *L. reticulatus* of the Atlantic.

Family CARAPIDÆ.

(*Fierasferidæ*).

350. **Jordanicus sagamianus** (Tanaka).

Misaki, No. 6070a.

This specimen corresponds to the account of *Carapus sagamianus*, except that the anal is under the base of the pectorals. It corresponds closely to the figure given by Franz. The maxillary being bound in the skin of the head, the species should be referred to *Jordanicus* Gilbert (*J. umbratilis* from Hawaii), and not to *Carapus* (*Fierasfer*).

Family OPHIDIIDÆ.

351. **Otophidium asiro** Jordan & Fowler.

Several specimens from Misaki, No. 6189a–b. Only the original type hitherto has been known.

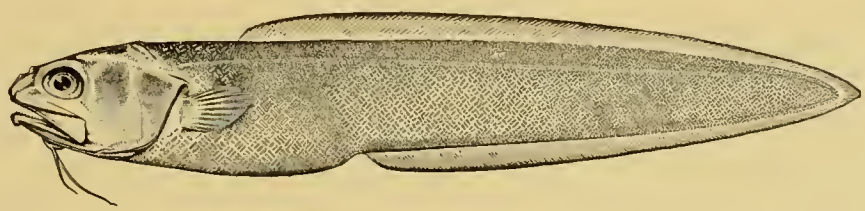


FIG. 78. *Otophidium asiro* Jordan & Fowler. (From Proc. U. S. N. M., Vol. XXV, p. 752).

Snout 2.2 to 2.5 in maxillary, which is 2.25 in head; longest ventral filament 2 in head. Tip of caudal colorless in all cases, although the dorsal and anal are broadly margined with black.

Family AMMODYTIDÆ.

352. **Ammodytes alascanus** Cope.

Yokohama, No. 6164a, not before known save from Bering Sea.

One specimen, larger in size than any of the common *A. personatus*.

D. 57, A. 30. Body-folds 160. Head 4.5; depth 11. It is slenderer than the type of *A. alascanus*, which was from Unalaska.

Family BROTULIDÆ.

353. **Spectrunculus radcliffei** gen. et sp. nov. (Plate XXXVII, fig. 3).

The new genus, *Spectrunculus*, may be thus defined:

Ventrals 2-rayed; caudal present, continuous with dorsal and anal; pectorals short, entire; ventrals each of two rays, fully joined, inserted under isthmus; mouth terminal, inclined toward vertical; no barbel; snout with strong dorsal convexity, leaving profile of head concave; teeth on premaxillaries and mandibles very minute;

eight branchiostegals; opercle with a strong straight spine; head otherwise unarmed. Scales obsolete; five lateral lines. Gill-filaments of first arch much reduced in size and coarseness, those remaining forming a "fluffy" mass. Pseudobranchiæ present, consisting of two well-developed, free filaments. Four gills, a slit behind fourth. The nearest ally of *Spectrunculus*, so far as known to us, is *Penopus* Goode and Bean.

The type of *Spectrunculus radcliffei* is No. 6061, Carnegie Museum, from Misaki (Coll. Owston) sixty-four millimeters in total length.

Head 5.8 in length to base of caudal, 6.2 in total; depth 4; snout 2.66 (measuring from anterior edge of eyeball); maxillary 2.5; distance from shout to anus 2.4; distance from snout to dorsal insertion 5.25 in body-length; D. 140; A. 110; P. 30; V. 2; C. 9 or 10; branchiostegals 8; gill-rakers short, 2+8 (with two or more rudiments).

Body compressed, its width just posterior to anus, contained 3.25 times in depth at the same place; body-cavity in type greatly distended, with viscera showing plainly through the skin; mouth turned sharply toward vertical, lower jaw strongly projecting; tip of snout at level of eye; a prominent knob-like convexity on its dorsal surface, reaching back to anterior edge of orbit; diameter of eye-ball half the length of oval orbit; maxillary extending midway between anterior edge of orbit and eye-ball; teeth on lower jaw only anteriorly, very minute, in a single row; a few microscopic ones on edge of premaxillary, besides minute serrations; no teeth could be distinguished on the projecting vomer; opercle with a single strong straight spine at upper angle, not extending beyond opercular flap; gill-openings extending forward below, not attached to isthmus. Gill-filaments on first arch delicate and much reduced, those on remaining arches large and curled, forming a tangled bunch without regular order.

Scales obsolete; side with five lateral ridges or lateral lines.

Dorsal inserted over pectoral; dorsal and anal continuous with caudal; pectorals short, rounded, on a base which is slightly pedunculate, or narrowed at its junction with body; ventrals inserted under eye, their length contained 1.5 in head, composed of two rays, fully united by membrane.

Body translucent, flesh-colored, with no pigment save in eye-ball.

Measurements in hundredths of body-length are as follows:—Head .17; depth .25; snout .05; eye-ball .05; maxillary .065; distance from snout to anus .43; from snout to dorsal insertion, .19.

This species is named for Mr. Lewis Radcliffe of the U. S. Bureau of Fisheries, in recognition of his work on the *Brotulidæ*.

354. **Neobythites sivicola** (Jordan & Snyder). (Plate XLII, fig. 2).

(*Watasea sivicola* Jordan & Snyder, not of Jordan & Starks).

Misaki (Coll. Owston).

The genus *Watasea*, based on this species, differs from *Neobythites* only in the presence of two weak spines on the pre-opercle, instead of three as in *Neobythites gilli*. Most of the species referred to *Neobythites* belong to the subgenus *Watasea*, as Radcliffe has lately shown.

This specimen, No. 6170a, C. M. Cat. Fishes, smaller than the type, is plainly identical with it. Body nearly uniformly gray, not banded as in *N. fasciatus*. Dorsal and anal broadly edged with black. This color has faded in the original types, both long exposed to sunlight.

In our young specimen the body is indistinctly covered with irregular faint whitish blotches, a row of these being along the dorsal base. The dorsal aside from these has no pattern anteriorly, being simply somewhat dusky, gradually becoming very black in the last quarter, save for a narrow white margin. This is continued on the caudal and anal, the latter being black with a white margin on the posterior three-fifths of its length, without other pattern. Specimens identified by Jordan & Starks as the young of *Watasea sivicola* are not the young of this species, as may be seen in the accompanying table of measurements. We refer these to Radcliffe's species, *N. fasciatus*.

Table of Comparative Measurements.

Locality.	*Neobythites fasciatus.*		*Neobythites Sivicola.*	
	Misaki.	Sagami.	Misaki.	Misaki (Type).
Body length	145	132	140	216
Head[8]	19	20	20	21
Depth	16	18	18	18
Snout	4.5	5	5	4.5
Maxillary	9	9	11	11
Pectoral	13.5	12	14	14
Ventral	12	11	15	14
Snout-vent	36	36	44	43
Snout-dorsal	22	23	25	25
Snout-ventrals	14.5	14.5	16.5	16
Dorsal rays	99	105	90	94
Anal rays	90	88	75	74
Scales (longitudinal)	125	120	130	120
Scales (mid-dorsal to lateral line)	8	8	8	8

Besides the differences in color, the present specimen of *Neobythites sivicola* shows a longer maxillary, lesser number of rays in both dorsal and anal, longer pectoral, longer distance from snout to vent, from ventrals to vent, and snout to ventrals. In these differences it is in full agreement with the type.

[8] Measurements given in hundredths of length without caudal.

The specimens recorded by Franz[9] as *Watasea macrops* (Günther) are undoubtedly the same as our *N. fasciatus*. As to the differences between this species and *N. macrops*, the coloration is not the same. We are unable, however, to find other differences, and it may be that the two forms are identical, the more so as Radcliffe[10] finds the two differing in nearly the same way from *N. fasciatus*. He however states that the fin-ray counts in *N. macrops* Günther are:—D. 96; A. 83, which is greater than that of our specimen.

355. **Neobythites fasciatus** Radcliffe.

One specimen, No. 6206a, one hundred and forty-eight millimeters in total length, from Misaki, very poorly preserved. The measurements are given in the comparative table under *N. sivicola*, and are the same as those of the specimen from Sagami Bay, which was described as the young of *N. sivicola* by Jordan and Starks.[11] As remarked above, the latter is plainly distinct, however, from *N. sivicola*. Radcliffe[12] (comparing specimens) regards these as probably the same as his *N. fasciatus*, and we are unable to find any differences which would justify questioning this decision, save that of color, as noted by Radcliffe. The spots on the fins of our specimen correspond to those on the fins of *N. fasciatus*, and there are indistinct traces of cross-bands present. We do not, however, find the vomerine teeth differing from those of *N. sivicola* as stated, those of the latter not being in a Y-shaped patch. According to Radcliffe, the vomerine patches of the teeth of *N. macrops* and *N. sivicola* are both Y-shaped, but Günther distinctly states them to be in a Λ-shaped patch in the type of *N. macrops*. Our observations on *N. sivicola* show a similar form, but somewhat more triangular.

Family BREGMACEROTIDÆ.

356. **Bregmaceros japonicus** (Tanaka).

Misaki, No. 6118a–b.

The usual Lernæan parasite with long egg-capsules is found on the side of the body. This species may be the same as *B. atripinnis* Tickell from off New Zealand.

Family GADIDÆ.

357. **Lotella phycis** (Temminck & Schlegel).

Sagami Bay, No. 4144a (Coll. Owston).

[9] Abh. d. Math.-phys. Klasse der K. Bayer, Akad. d. Wiss. IV., Suppl. Bd. 1., Abhandlg., 1910, p. 30.

[10] Proc. U. S. N. Mus., Vol. 44, 1913, p. 144.

[11] Bull. U. S. Fish. Comm., XXII, 1902, p. 601.

[12] Proc. U. S. Nat. Mus., Vol. 44, 1913, p. 144.

Family MACROURIDÆ.

358. **Coryphænoides bona-nox** sp. nov. (Plate XXXVIII, figs. 1 & 1a).

The type is a single large example from Sagami Bay, three hundred millimeters long, No. 6462 Carnegie Museum Catalog of Fishes.

Head 4 in length without caudal; depth 5 (1.2 in head); snout 3.6 in head; eye 4; maxillary 2.4; D. II, 9, 84; A. 78; P. 19; scales 125, between first dorsal spine and lateral line 8.

Snout slightly longer than eye, firm in texture, especially at apex and lateral angles; maxillary reaching almost to below posterior margin of eye; profile of head evenly arched from dorsal, save slight flat area above eyes; interorbital space nearly as wide as eye, flat; pre-orbital convex, forming a low, rounded ridge with side of snout, not, however, sharply dividing head into upper and lower parts; snout projecting over premaxillaries a distance equal to two-thirds diameter of eye; teeth in narrow bands in both jaws; two or three series of small, rather blunt teeth anteriorly, dwindling to a single one posteriorly, outer teeth not enlarged; mandibular barbel half diameter of eye; first branchial arch with fold of membrane crossing it, attaching it to opercular wall; anterior gill-slit two-thirds of diameter of eye in length; five gill-rakers, tubercle-like; anus as far behind ventral base as postorbital length of head.

Dorsal inserted over pectoral base, which is over that of ventrals; second spine not filamentous, its length contained twice in head, its lower half smooth, its upper half with six or seven coarse spinules; second dorsal inserted behind first, a distance equal to length of base of latter and before anus; first ray of second dorsal 3.5 in base of first; anal inserted under fifth ray of second dorsal, anus immediately preceding; ventrals filamentous, longest ray 1.75 in head, reaching anus; pectorals 1.75 in head, not filamentous.

Scales hard to the touch, with six to eight strong radiating ridges, their spinules closely imbricate and each closely applied to that following, the last spinule projecting beyond scale-border in each ridge; scales on suborbital and snout with greatly thickened, bony ridges, frequently but one or two in number; scales present everywhere on head and body save lips and throat; no scaleless area between ventrals.

Color uniformly dark brown; all fins very dark.

The dentition and scales of this species distinguish it from previously known forms.

The senior author has studied the fishes of America and of the world for over forty years. His attention is now turning from Ichthyology and Taxonomy to larger but less charming studies in the relations of nations. This is, no doubt, the

last of his long array of new species of fishes. He follows the precedent of Linnaeus[13] in closing his work with "Good-night!"

359. **Coryphænoides garmani** Jordan & Gilbert.
Boshu, No. 6184a; Misaki, No. 6325a.

360. **Coryphænoides misakius** Jordan & Gilbert.
Misaki, No. 6029a–b.
D. II, 11, 150 to 160; A. 160 to 170; P. 21; V. I, 7; Scales 220 to 240, in transverse series 11/30. Identical with the type.

361. **Macrourus nasutus** (Günther).
Misaki, No. 6322a–b; Sagami Bay, No. 4107a–c; in deep water.

362. **Macrourus asper** Günther. (Plate XXXVIII, fig. 2).
Misaki in deep water. We refer our example, which we figure, to *Macrourus asper*.

363. **Cœlorhynchus japonicus** (Temminck & Schlegel).
Misaki, No. 6207a (Coll. Owston).
D. II, 8.

364. **Cœlorhynchus anagirostris** Jordan & Gilbert.
Misaki, No. 6155a (Coll. Owston).
This specimen (21 cm. long) is smaller than the type, with larger eye and shorter snout.

Family PLEURONECTIDÆ.

365. **Pseudorhombus misakius** Jordan & Starks.
Osaka, No. 6374a–b.

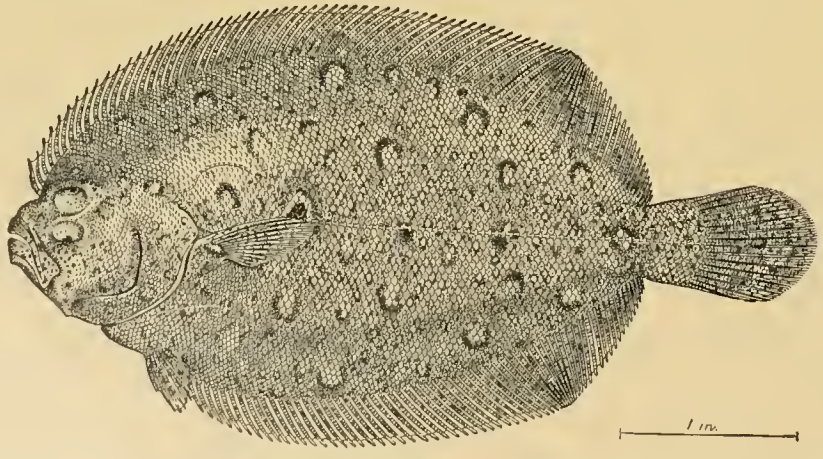


Fig. 79. *Pseudorhombus misakius* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXXI, p. 175).

[13] *Convolvulus bona-nox* Linnæus.

366. **Pseudorhombus cinnamomeus** (Temminck & Schlegel).
Shimonoseki, No. 6405a.

367. **Pseudorhombus ocellifer** Regan.
Shinabara, Misaki, No. 6192a–c.
D. 74; A. 54. Scales 64.

368. **Tarphops oligolepis** (Bleeker) gen. nov. (Plate XXXIX).

The genus *Tarphops*, based on *Pseudorhombus oligolepis* Bleeker, is closely allied to *Pseudorhombus* Bleeker, differing in its much larger scales, these being about forty in a lateral series instead of from sixty to eighty. The lateral line, as in *Pseudorhombus*, has an accessory branch and an arch; eyes close together on the left side; species only attaining a very small size.

We here describe two small specimens, the longest seventy-four millimeters in total length, from Misaki, No. 6010a, and 6455a. The description given by Günther is not complete, nor is the generally inaccessible original description by Bleeker. The species has not been found since the original specimen, sixty-four millimeters in length, was described.

Head 3.5 in body-length, without caudal; depth 1.9; lower eye 4 in head; snout equal to eye; maxillary 2.5 in head; dorsal rays, sixty-two; anal, forty-eight; scales in lateral series, forty; pores in lateral line, forty-two; scales in transverse series in deepest part of body 13/14.

Eyes very close together, on left side; interorbital ridge very narrow, and but slightly elevated; upper eye slightly in advance of lower; maxillary nearly vertical; premaxillary processes forming a marked convexity, or knob, in the profile of the snout; teeth very small, in a single row, those on the lower jaw slightly curved; on blind side of upper jaw, thirty; on eyed side, thirty-four; on blind side of lower jaw, eighteen, on eyed side, twenty-six; none on vomer or palatines; gill-rakers 7+16, long and slender, longest equal to half diameter of eye; anterior nostril of both sides with a flap.

Dorsal fin inserted opposite anterior edge of eye, highest at about thirty-fifth ray, which is 2 in head; all the rays simple; anal similar in form and height; caudal rounded, middle rays equal to length of head; pectoral slightly shorter, with ten rays; ventral of eyed side along edge of abdomen, as long as diameter of eye; ventral of blind side removed from edge, slightly longer than other; pectoral of blind side 2.2 in head.

Scales ctenoid on both sides of body, present everywhere save on snout and tips of jaws; those on interorbital space in one row, extending along front of upper eye; wide-set scales on each ray of dorsal and anal fins, other fins naked.

Lateral line strongly arched above pectoral, height of curve two-fifths of its chord; an accessory line running to seventh dorsal ray.

Color olivaceous, with irregular brownish spots, two rows on vertical fins and three irregular transverse rows on caudal; peritoneum pigmented.

This species is thus far known only from three small specimens, one from Nagasaki (Bleeker) and the present two from Misaki. One of our specimens has large, nearly ripe ova, and cannot be termed young.

369. **Scæops kobensis** Jordan & Starks.

Of this species we have four examples from Misaki, two of which are in the Carnegie Museum, No. 6086a–b. They are respectively sixty, sixty-two, sixty-three, and seventy-five millimeters in total length. Of these three are females, two of them with large ova in well developed gonads, and one a male. The

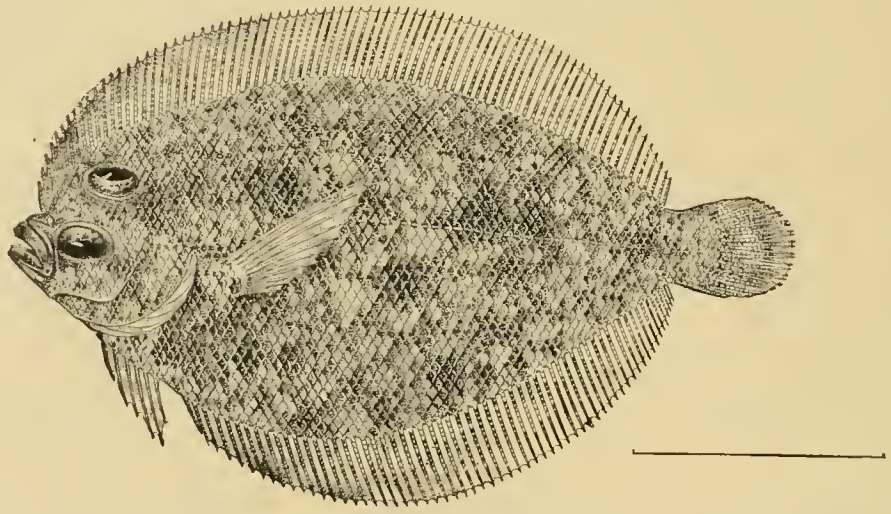


Fig. 80. *Scæops kobensis* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXXI, p. 171).

latter is distinguished externally by the very broad interorbital space and much deeper head, the first being contained 3.8 in the length of the head, whereas in the case of the female it is contained seven or eight times in the head. The pectoral of the male is likewise longer. The depth of the head in the male equals the length of the head, while in the females it is decidedly less. Dorsal rays, 76–80; anal, 61–63; scales, 49–52. The type of the species (No. 9822, Stanford University Collection) is a large female, corresponding to our specimens, save for somewhat wider interorbital space, due to roe.

370. **Paralichthys olivaceus** (Temminck & Schlegel).

Shimonoseki, No. 6311a; Osaka; Misaki, No. 6395a.

D. 79; Scales 110.

371. **Xystrias grigorjewi** (Herzenstein).
(*Verasper itakii* Jordan & Snyder).
Straits of Tsushima, found in Osaka market. (No. 6281a–i).

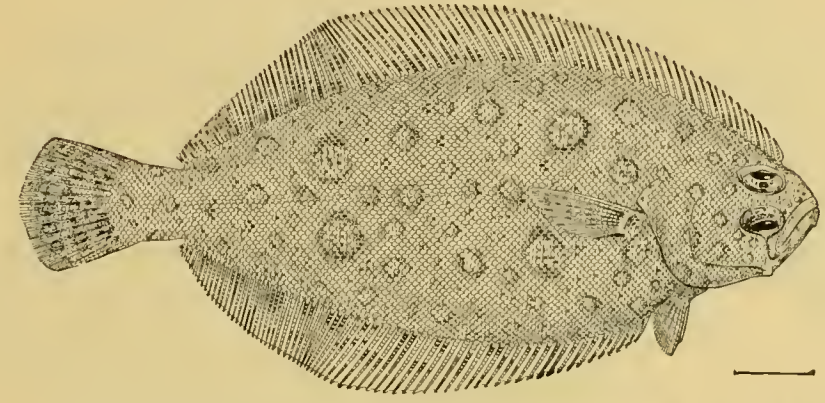


Fig. 81. *Xystrias grigorjewi* (Herzenstein). (From Proc. U. S. N. M., Vol. XXXI, p. 183).

Much faded, but not different from examples from Hakodate.

372. **Pleuronichthys cornutus** (Temminck & Schlegel).
Osaka, No. 6372a–b; Misaki, No. 6338a.

373. **Lepidopsetta bilineata** (Ayres).
(Mem. Carn. Mus., Vol. VI, fig. 62, p. 61).
Shinabara.

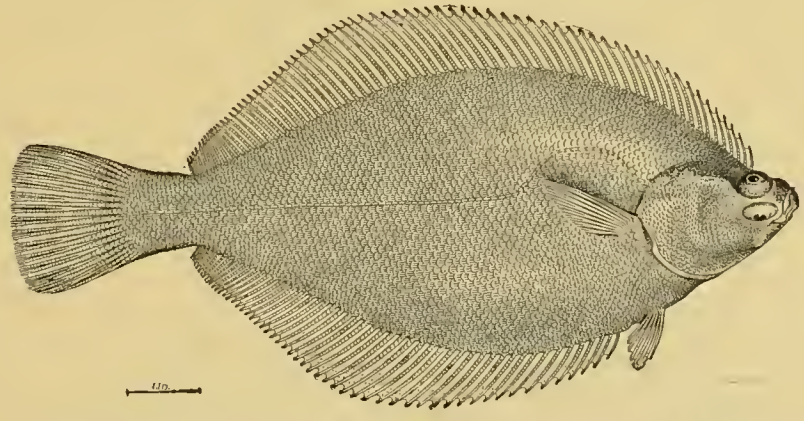


Fig. 82. *Limanda angustirostris* Kitahara. (From Proc. U. S. N. M., Vol. XXXI, p. 208).

374. **Limanda angustirostris** Kitahara.
Matsushima Bay, No. 6317.
D. 73; A. 54. Scales 76.

375. **Limanda yokohamæ** (Günther).
Shinabara, near Tokyo, No. 6160a.

376. **Kareius bicoloratus** (Basilewsky).
Osaka, No. 6066a.

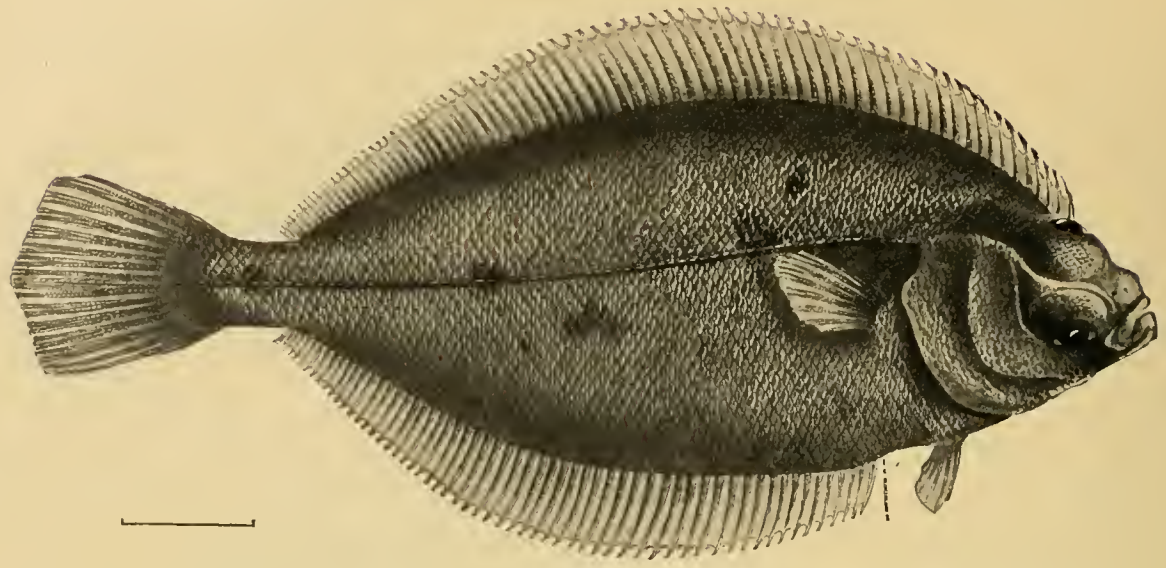


Fig. 83. *Dexistes rikuzenius* Jordan & Starks. (From Proc. U. S. N. M., Vol. XXXI, p. 213).

377. **Dexistes rikuzenius** Jordan & Starks.
(*Araias ariommus* Jordan & Starks).

Two specimens of this deep-water flounder from Tsushima Straits were taken in the market of Osaka. One, No. 6342a, is in the Carnegie Museum.

Eyeball scaly above. Head 4.16 in length; dorsal rays, sixty-nine and seventy-three, anal rays, fifty-seven and fifty-nine. Scales, sixty-five and sixty-seven (pores), gill-rakers x+7.

In the type of *Araias ariommus*, the eyeball is also scaly above and the two are identical.

378. **Platichthys stellatus** (Pallas).
(Mem. Carn. Mus., Vol. VI, p. 60, fig. 61).
Matsushima Bay, No. 6339a, a subarctic species, rare thus far to the southward.

Family SOLEIDÆ.

379. **Aseraggodes kobensis** (Steindachner).
Misaki, No. 6114.

380. **Amate japonica** (Temminck & Schlegel).
Shimonoseki, No. 6225a–d; Misaki, No. 6396a–j.

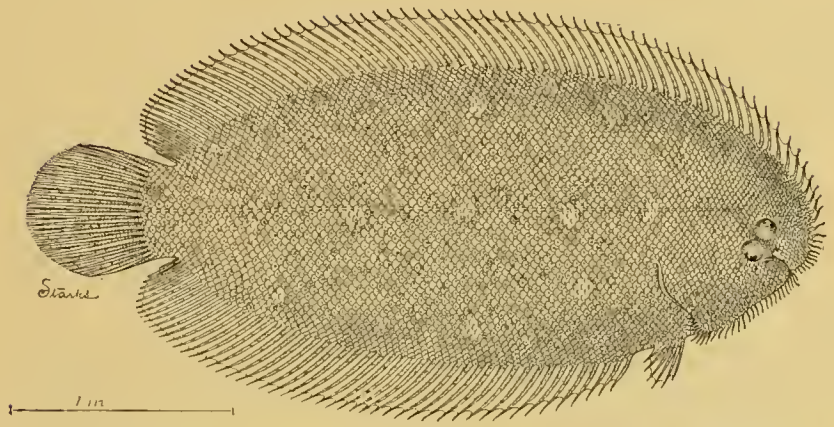


FIG. 84. *Aseraggodes kobensis* (Steindachner). (From Proc. U. S N. M., Vol. XXXI, p. 230).

381. **Zebrias zebrinus** (Temminck & Schlegel).
Misaki, No. 6373a; Shimonoseki.

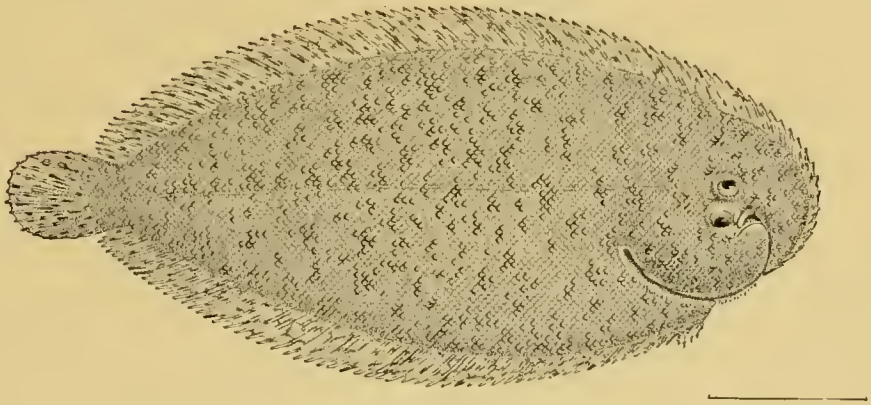


FIG. 85. *Amate japonica* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXXI, p. 228).

382. **Zebrias japonicus** (Bleeker).
Kobe, No. 6215a; Misaki, No. 6180a (Coll. Manabe).

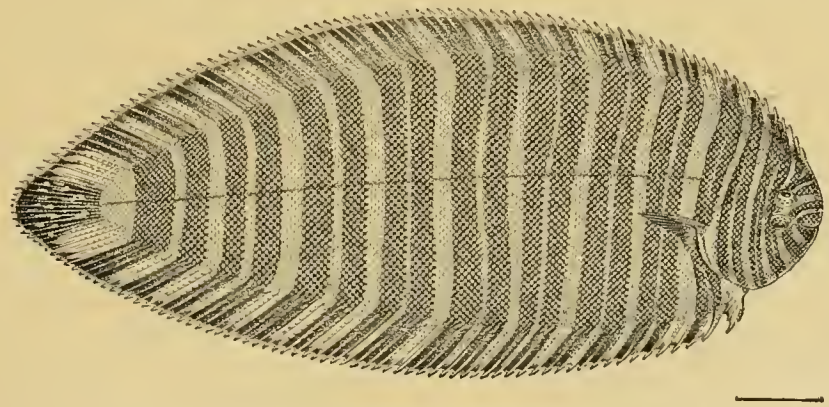


FIG. 86. *Zebrias zebrinus* (Temminck & Schlegel). (From Proc. U. S. N. M., Vol. XXXI, p. 233).

383. **Rhinoplagusia japonica** (Temminck & Schlegel).

Shimonoseki, Misaki, No. 6312.

The name *Rhinoplagusia* of Bleeker has priority over *Usinosita*, based on the same type *japonica*.

384. **Areliscus interruptus** (Günther).

Misaki.

Family TRACHYPTERIDÆ.

385. **Trachypterus ishikawæ** Jordan & Snyder.

A small specimen from Sagami Bay, 86 cm. long, No. 6384a, which has lost a part of the tail and caudal fin, corresponds completely with the description of the type, save that in the latter the pre-orbital is described as " very wide, radiate, rugose." This is a clerical error, the maxillary being meant, as is evident from the large adult example in the Stanford Collection and the illustration of the type. The pre-orbital is about 5 in the eye, not bony, nor prominent. The premaxillaries are greatly protractile and in the type they are fully extended, as is evident from the plate. The premaxillary processes extend to the nape, slightly behind the eye.

The teeth are slightly longer and more prominent than in our large adult example. The vomer has similar teeth.

Family LOPHIIDÆ.

386. **Lophiomus setigerus** (Vahl).

Misaki, No. 6082a–b.

FAMILY ANTENNARIIDÆ.

387. **Antennarius tridens** (Temminck & Schlegel).

Misaki, No. 6383a–b; Kobe.

388. **Antennarius nox** Jordan.

Misaki, No. 6382a.

A large example, with the color-pattern of the type, but the ground-color pale, not jet-black.

Family CERATIIDÆ.

389. **Chaunax fimbriatus** Hilgendorf.

A small specimen, No. 6035a, one hundred and eighty millimeters long from Misaki, together with two specimens from Sagami Bay, collected by the Albatross, differ from an Atlantic specimen of *Chaunax pictus* Lowe in the extension of the rostral tentacle back of the anterior border of the eyes, the coarser character of the skin prickles, and larger eye, as well as in the presence of filaments on the lower side of the body.

The eye in *C. pictus* is .09 of body-length, in *C. fimbriatus* .07–.075 in specimens of same size.

Günther[14] regards these two species as synonymous, but makes no remark on the above mentioned characters.

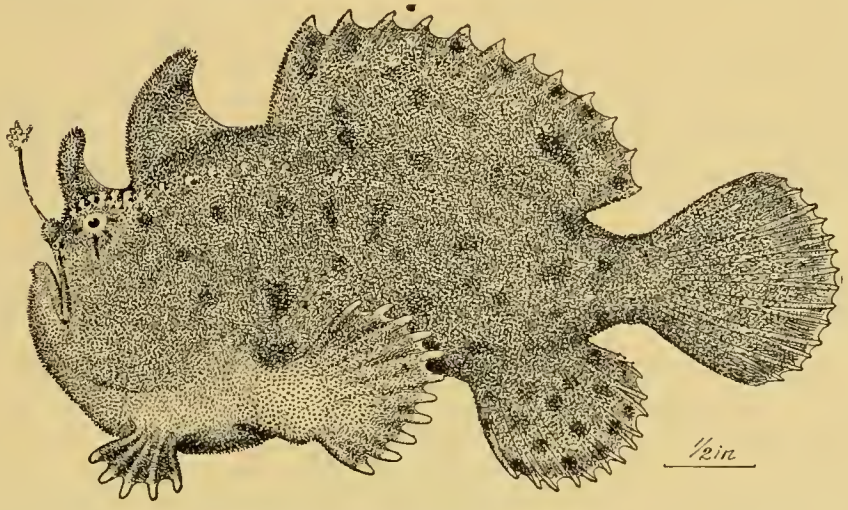


FIG. 87. *Antennarius nox* Jordan. (From Proc. U. S. N. M., Vol. XXIV, p. 376).

Family OGCOCEPHALIDÆ.

390. **Halieutæa stellata** (Vahl).

Boshu; Sagami Bay; Misaki, No. 6142a–b.

The smallest of these specimens shows a much narrower disk than the others, its breadth equal to the distance from the snout to the last of the base of the dorsal fin and an absence of small prickles between the larger spinules of the disk. The larger two show these prickles and a broader disk, equal to the distance from the snout to the pectoral angle. These, however, on comparison with other specimens are shown to be extremes of variations.

[14] Challenger, Deep Sea Fishes, p. 58.

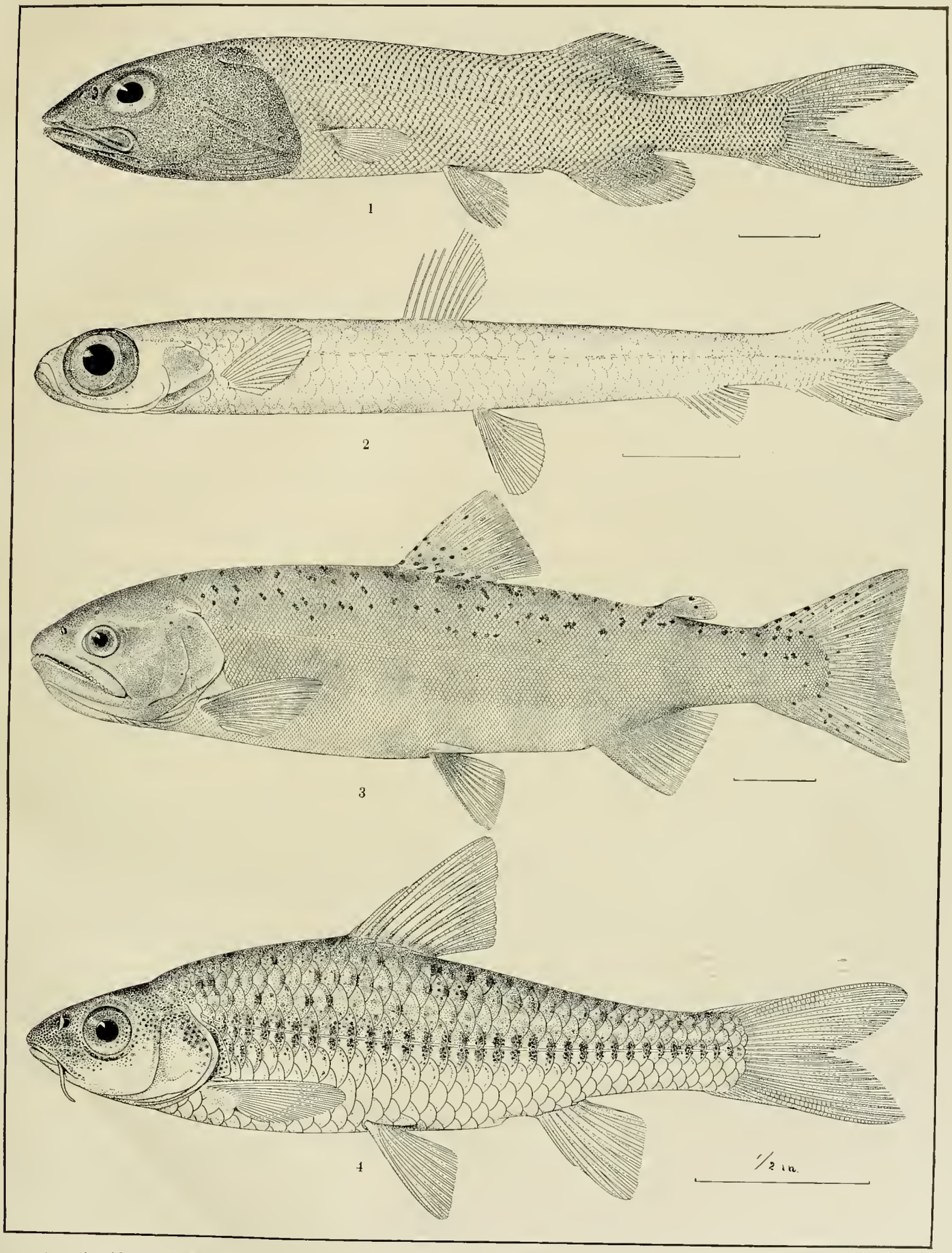


FIG. 1. *Alepocephalus umbriceps* JORDAN & THOMPSON. FIG. 2. *Nansenia ardesiaca* JORDAN & THOMPSON. FIG. 3. *Oncorhynchus masou* (BREVOORT). FIG. 4. *Gnathopogon ishikawæ* JORDAN & THOMPSON.

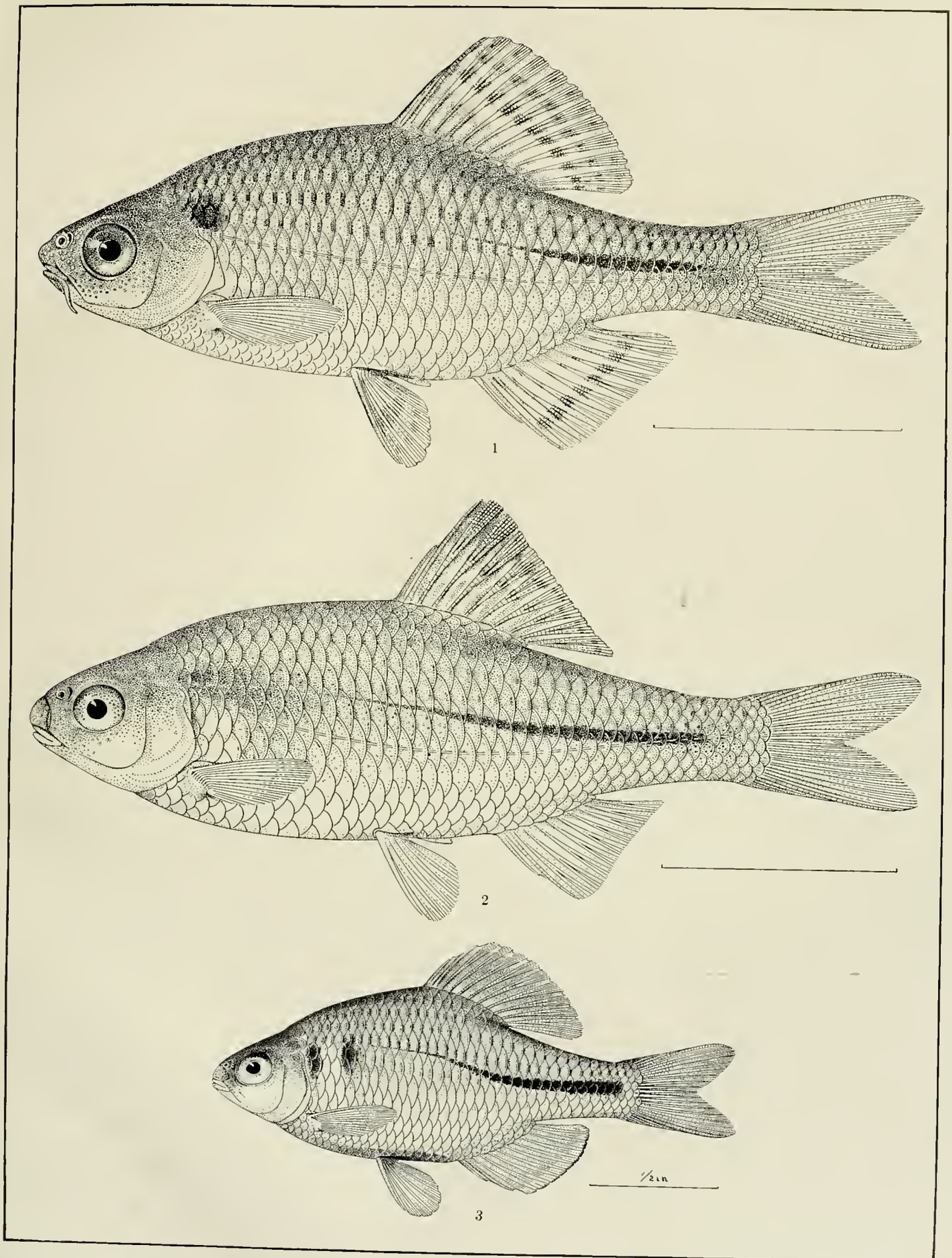


FIG. 1. *Acheilognathus tabira* JORDAN & THOMPSON. FIG. 2. *Acheilognathus moriokæ* JORDAN & THOMPSON.
FIG. 3. *Acanthorhodius atremius* JORDAN & THOMPSON.

FIG. 1. *Acanthorhodius sciosemus* JORDAN & THOMPSON. FIG. 2. *Rhodeus kurumeus* JORDAN & THOMPSON.
FIG. 3. *Pseudaspius atrilatus* JORDAN & THOMPSON.

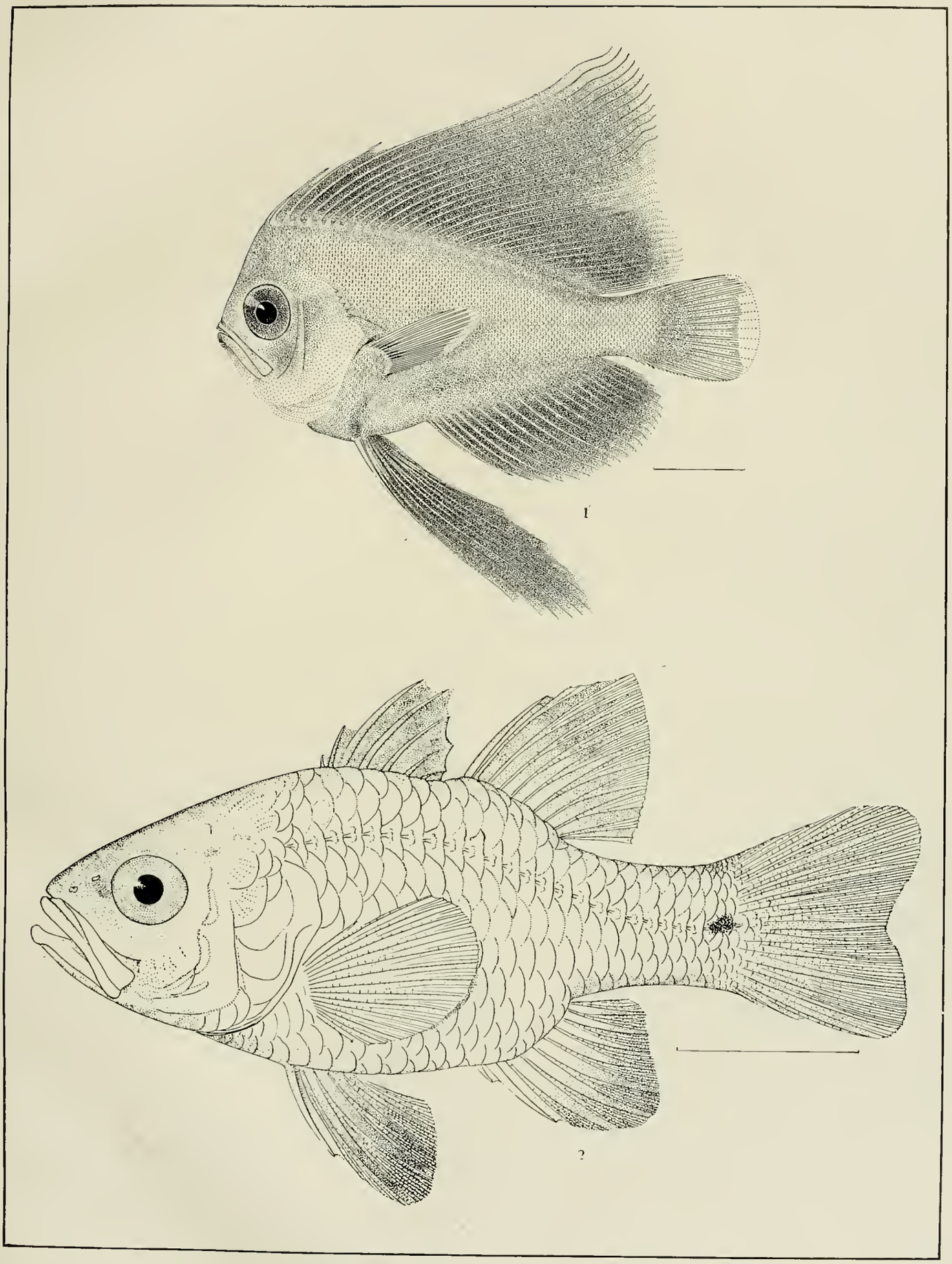


FIG. 1. *Caristius macropus* (BELLOTTI). FIG. 2. *Amia sialis* JORDAN & THOMPSON.

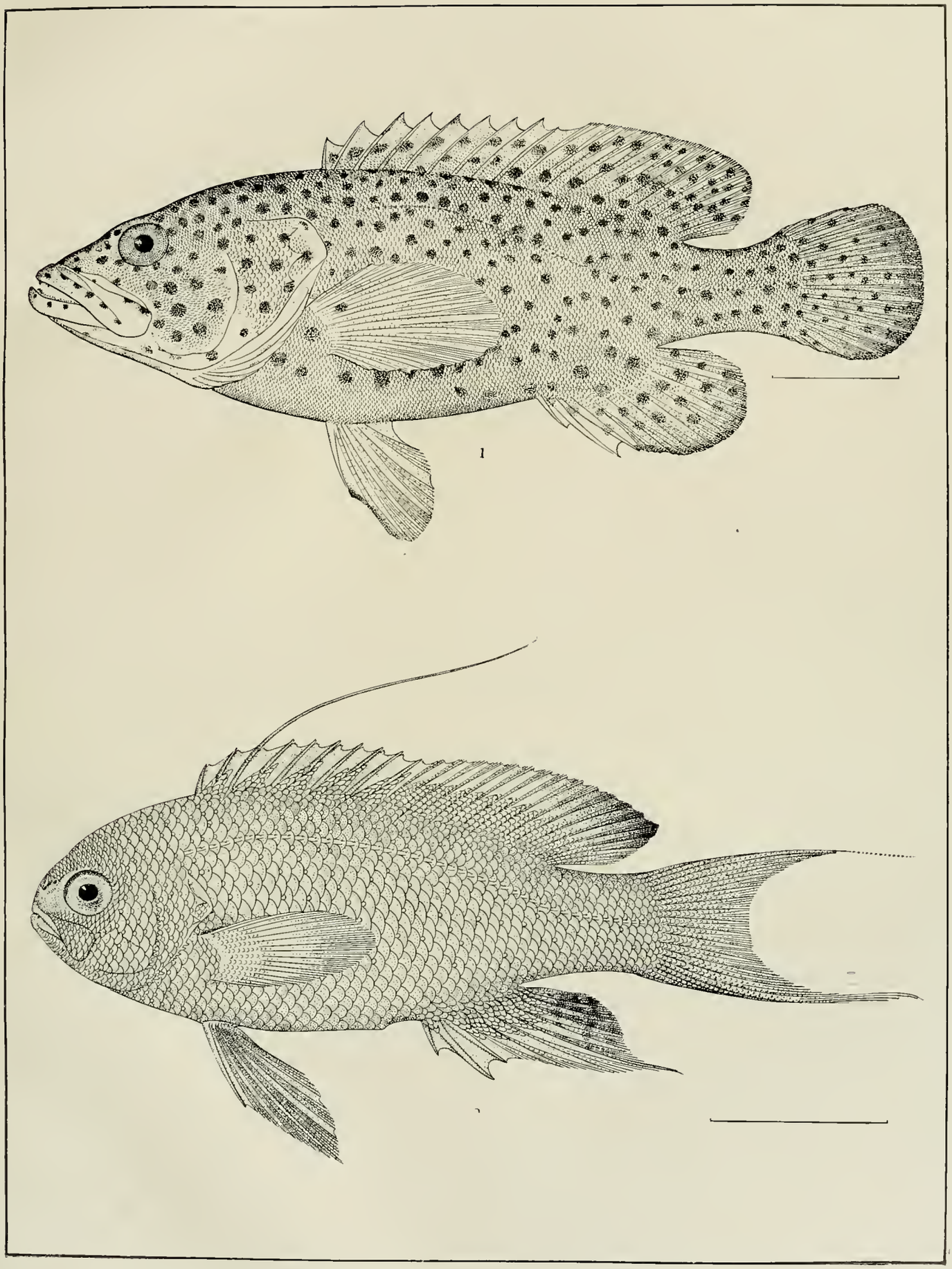


FIG. 1. *Cephalopholis boninius* JORDAN & THOMPSON. FIG. 2. *Franzia nobilis* (FRANZ).

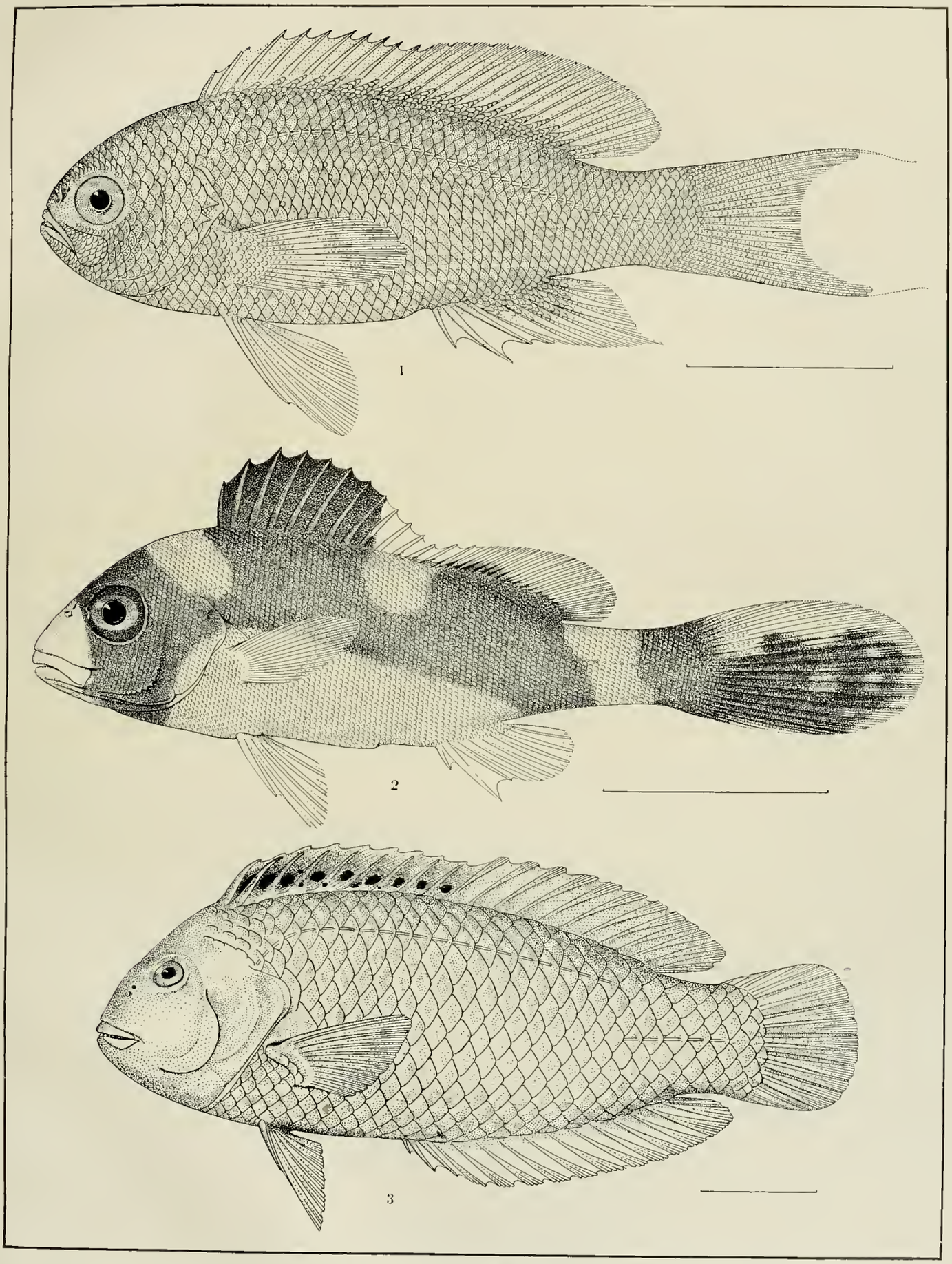


FIG. 1. *Franzia ardens* JORDAN & THOMPSON. FIG. 2. *Plectorhynchus pica* (CUVIER & VALENCIENNES).
FIG. 3. *Xyrichthys sciistius* JORDAN & THOMPSON.

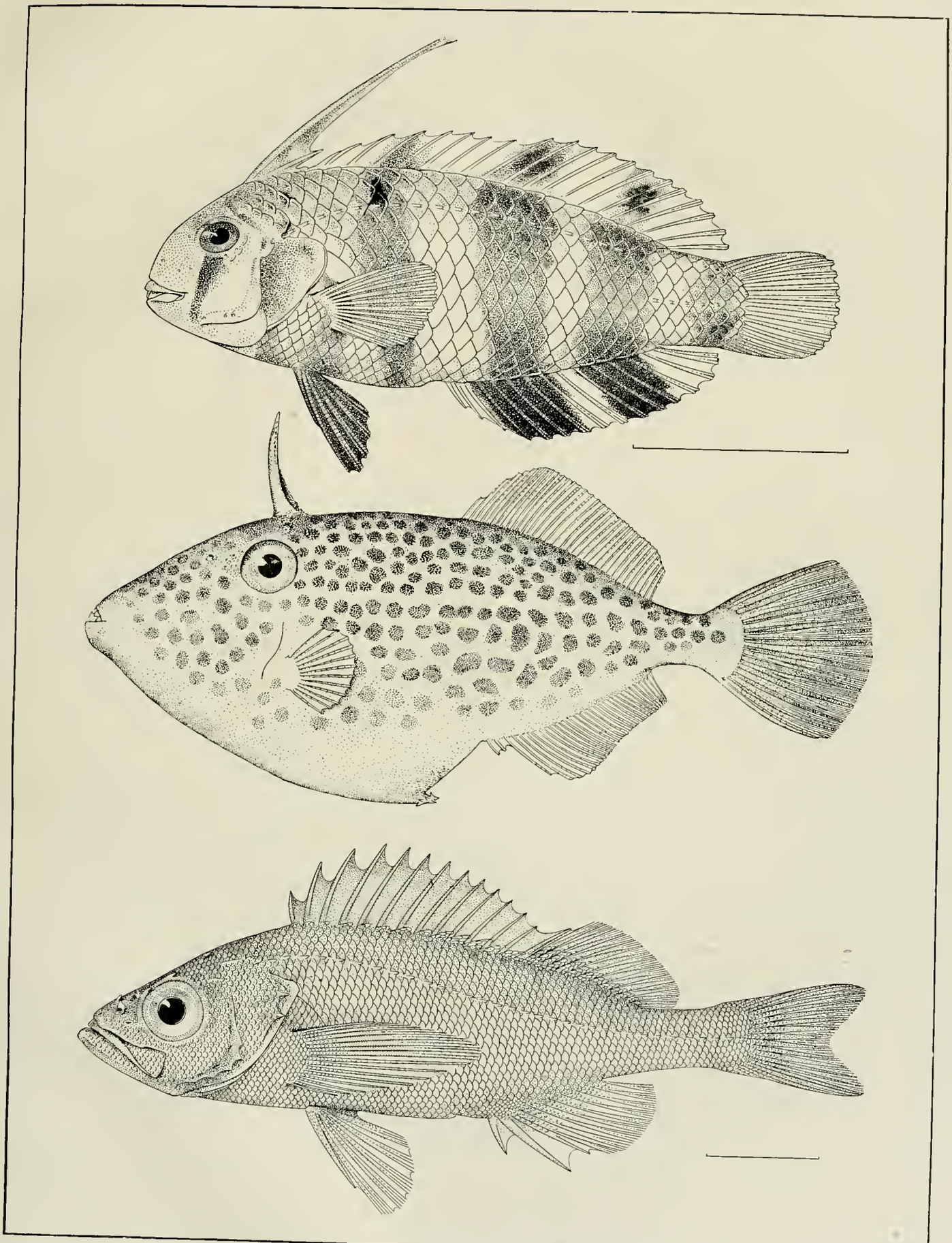


FIG. 1. *Inniistius dea* (TEMMINCK & SCHLEGEL). FIG. 2. *Pseudomonocanthus nigromaculatus* (TANAKA).
FIG. 3. *Sebastodes owstoni* JORDAN & THOMPSON.

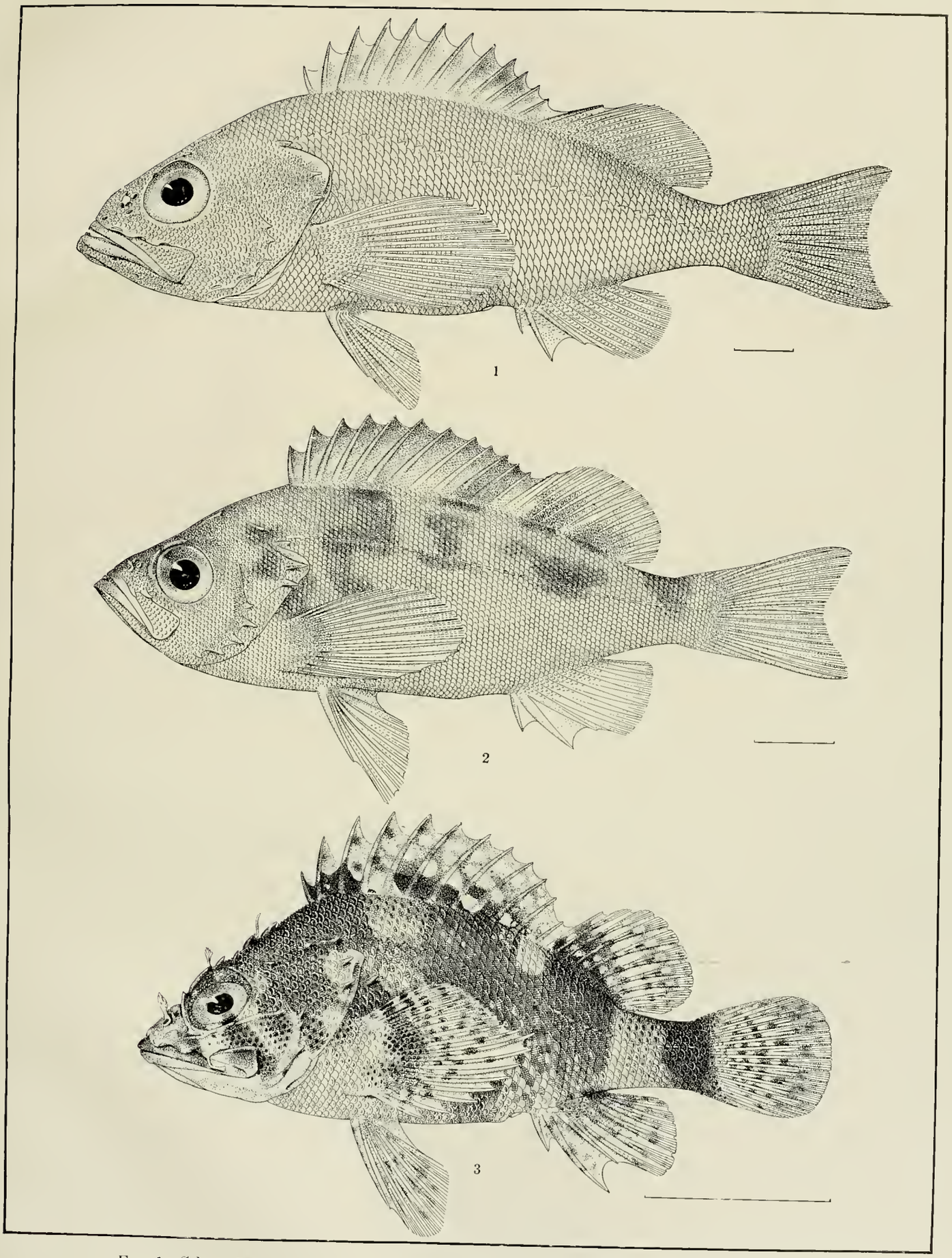


FIG. 1. *Sebastodes flammeus* JORDAN & STARKS. FIG. 2. *Sebastodes joyneri* (GÜNTHER).
FIG. 3. *Thysanichthys evides* JORDAN & THOMPSON.

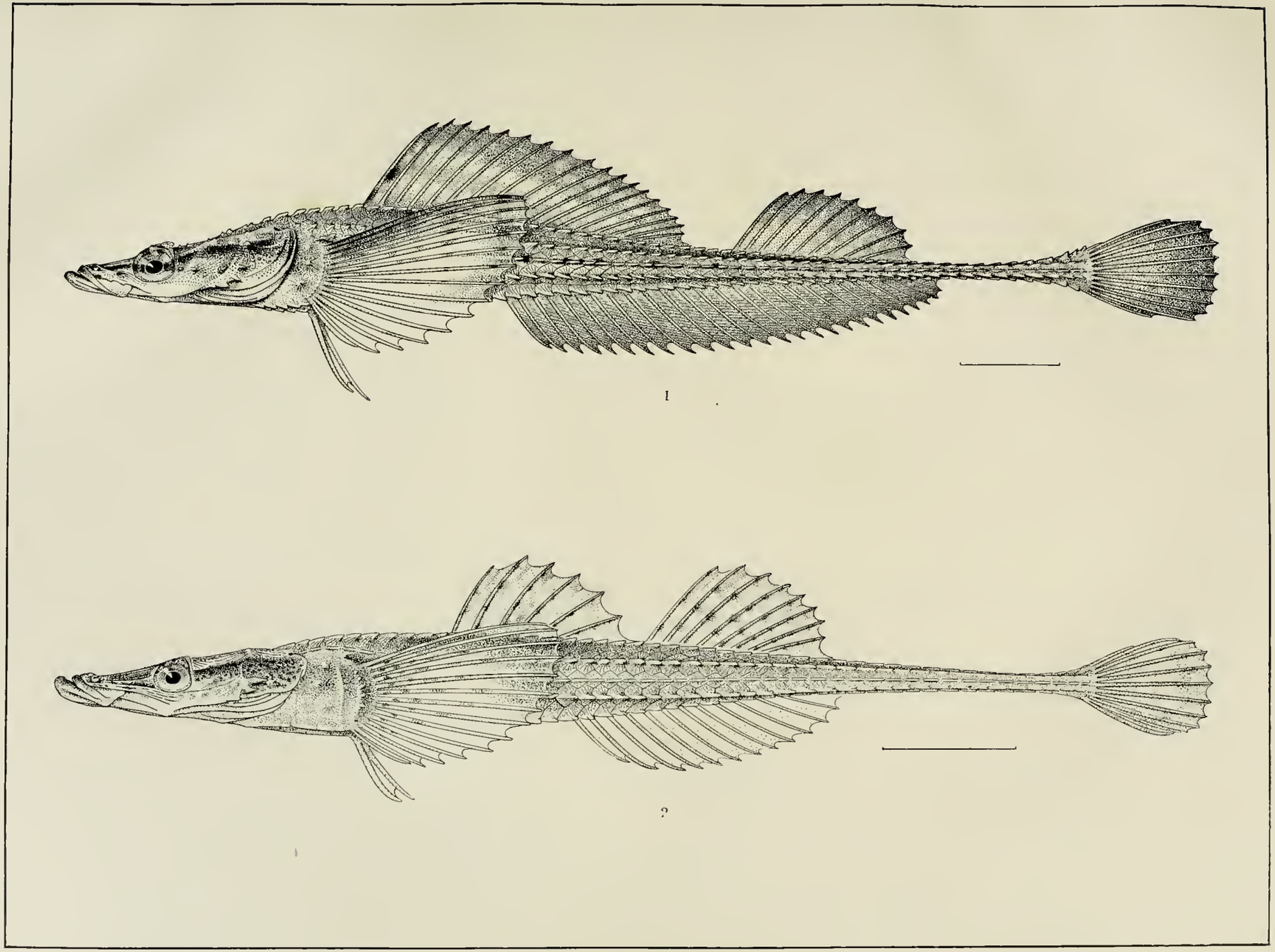
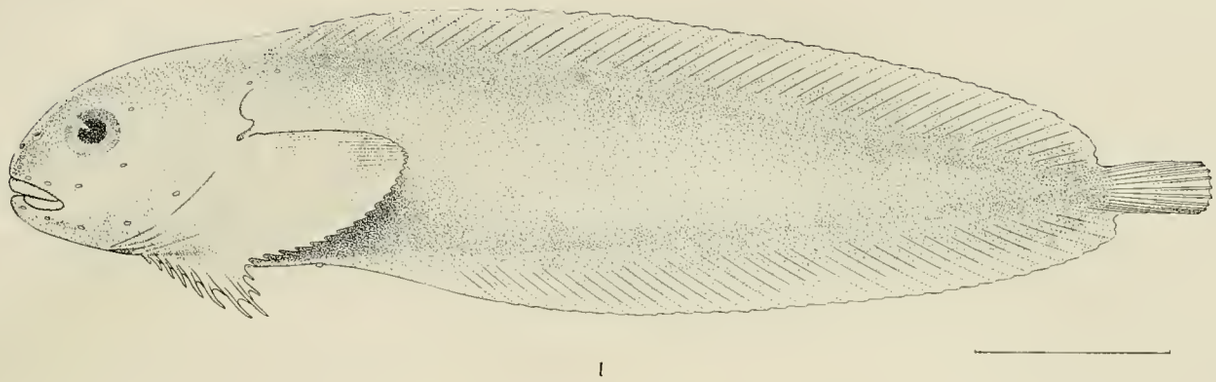


FIG. 1. *Tilesina gibbosa* SCHMIDT. FIG. 2. *Brachyopsis rostratus* (TILESIUS).



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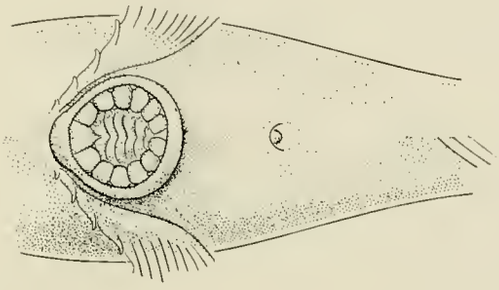

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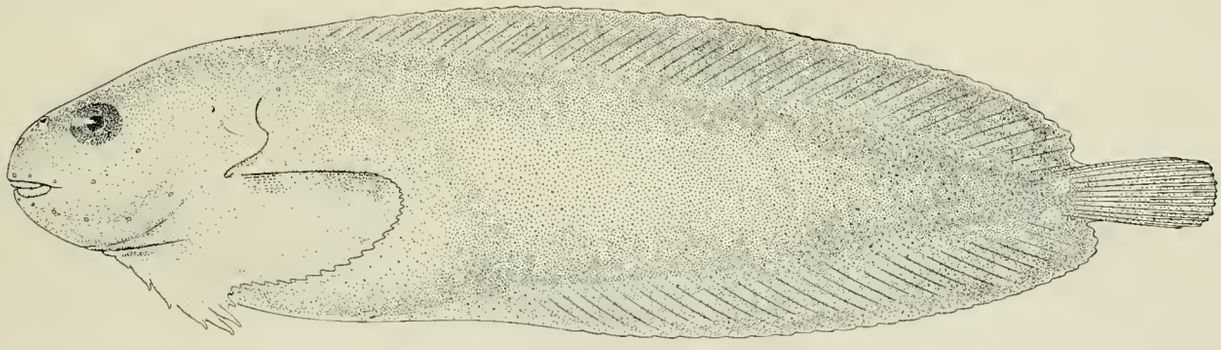

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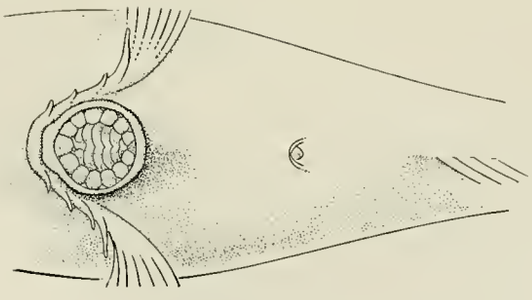


2 a

FIG. 1. *Careproctus gilberti* JORDAN & THOMPSON. FIG. 1a. *Careproctus gilberti* JORDAN & THOMPSON.
FIG. 2. *Careproctus burkei* JORDAN & THOMPSON. FIG. 2a. *Careproctus burkei* JORDAN & THOMPSON.

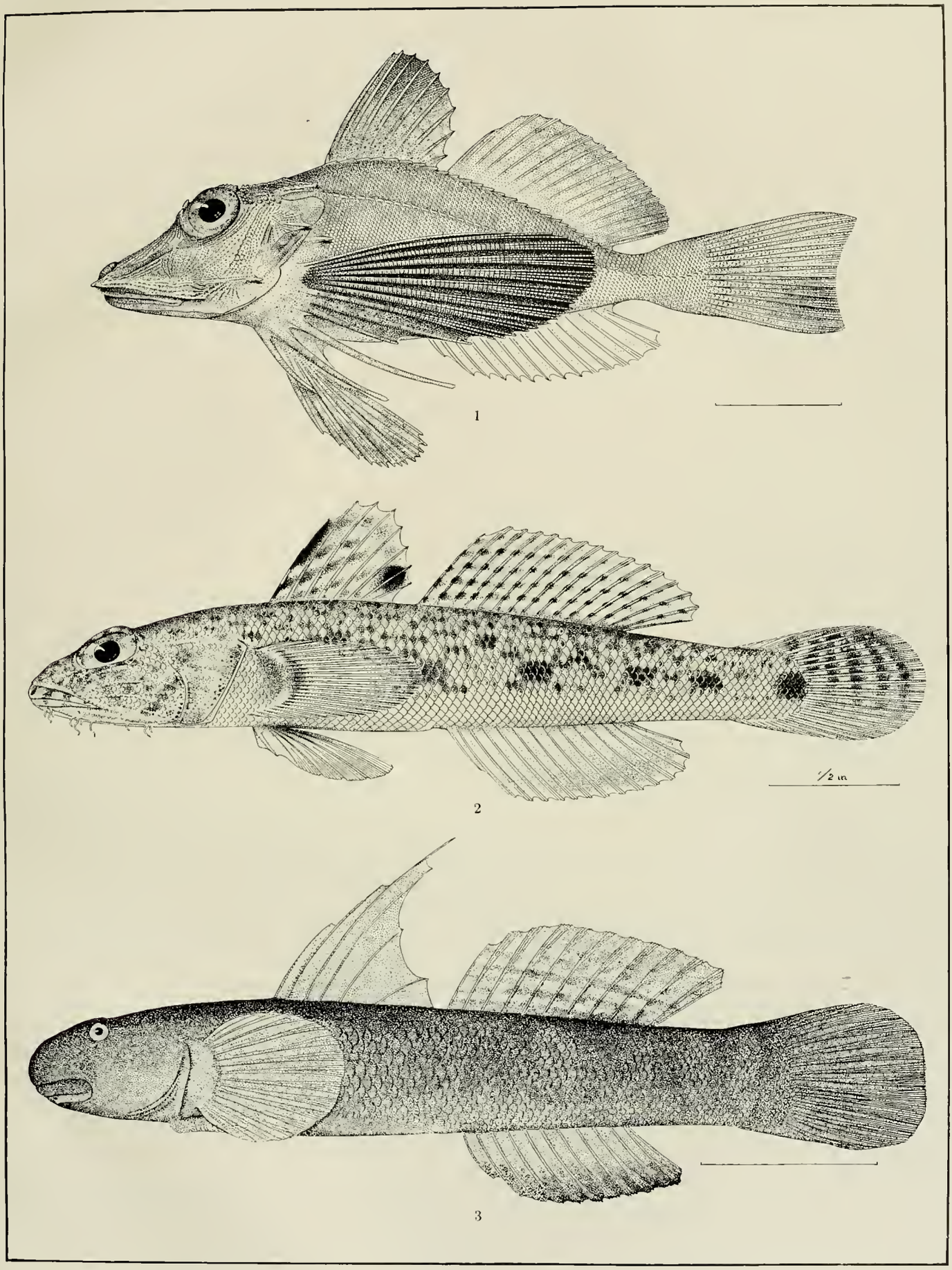


FIG. 1. *Chelidonichthys ischyrus* JORDAN & THOMPSON. FIG. 2. *Aionosus geneionemus* (HILGENDORF). FIG. 3. *Sicyopterus japonicus* (TANAKA).

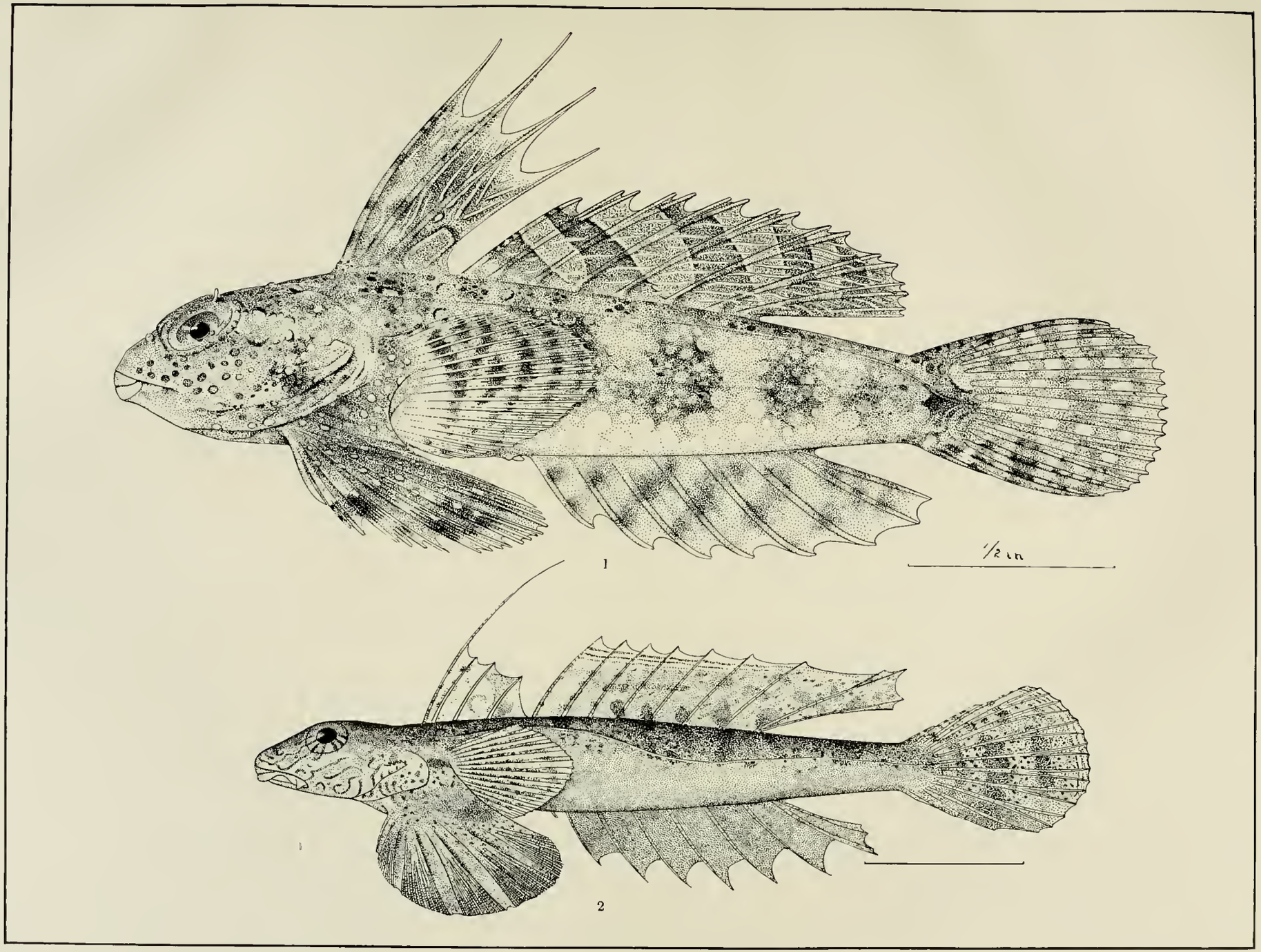


FIG. 1. *Synchiropus ijimæ* JORDAN & THOMPSON. FIG. 2. *Calymmichthys xenicus* JORDAN & THOMPSON.

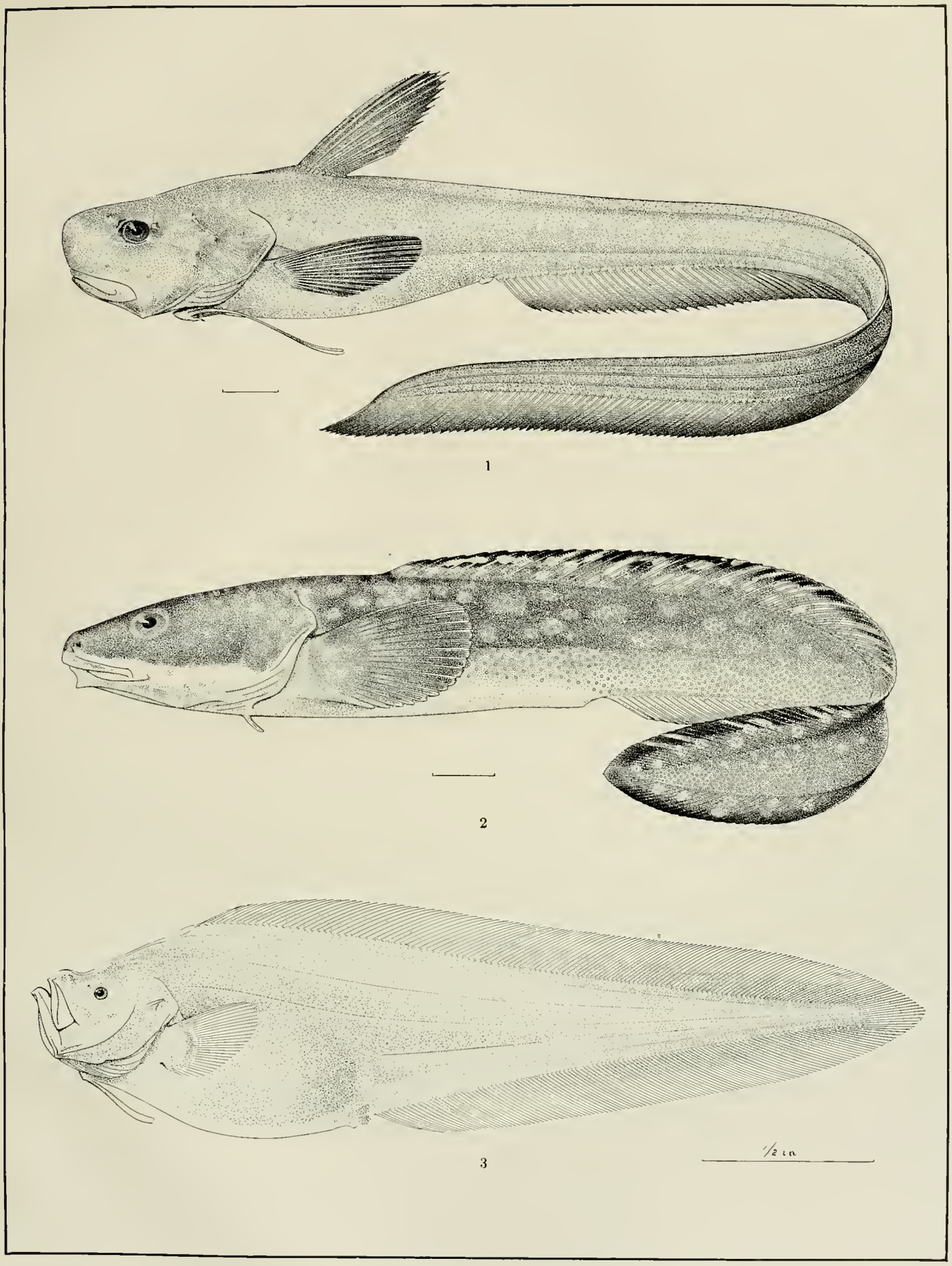


FIG. 1. *Ateleopus japonicus* BLEEKER. FIG. 2. *Lycodes tanakæ* JORDAN & THOMPSON.
FIG. 3. *Spectrunculus radcliffei* JORDAN & THOMPSON.

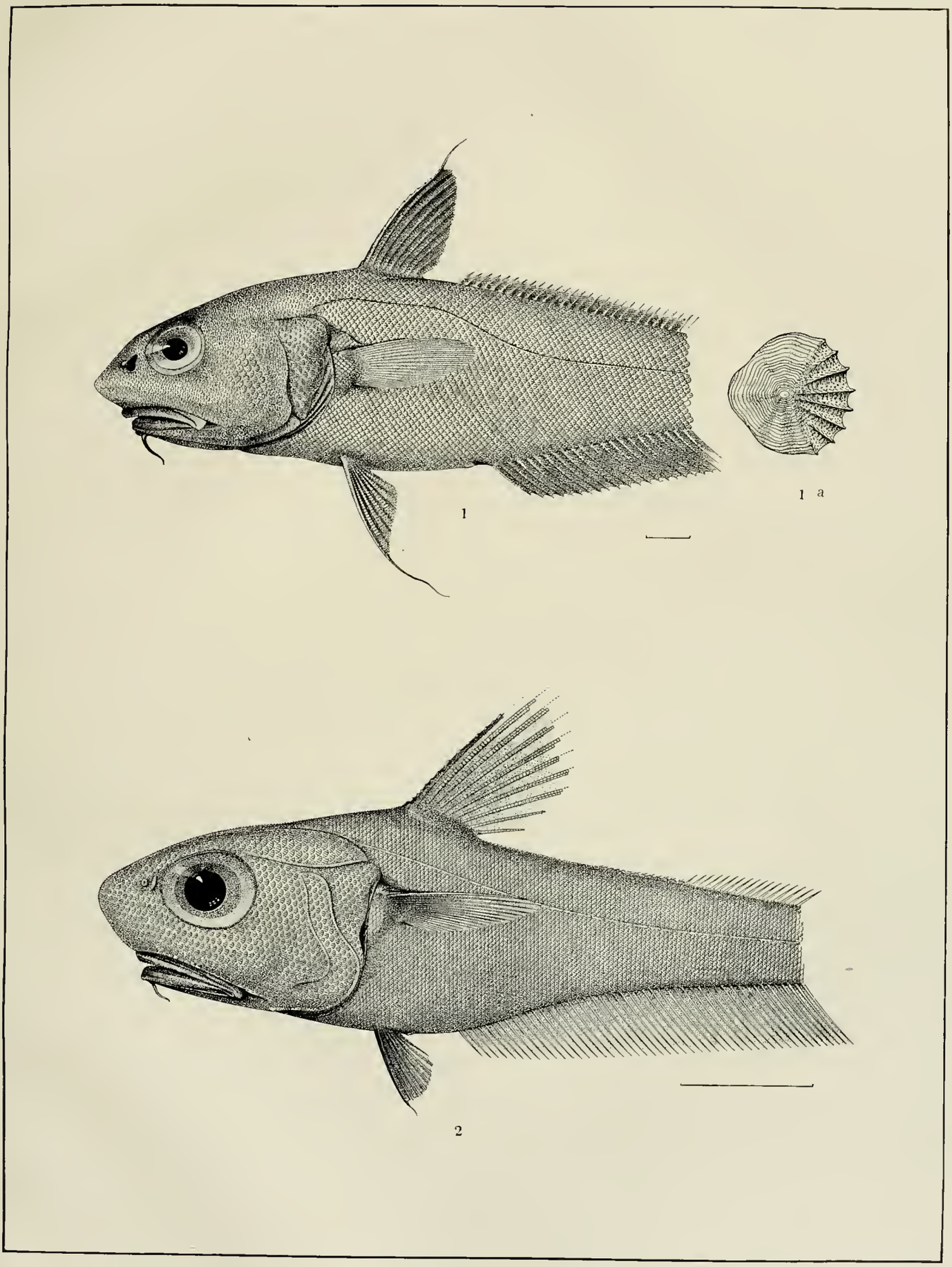
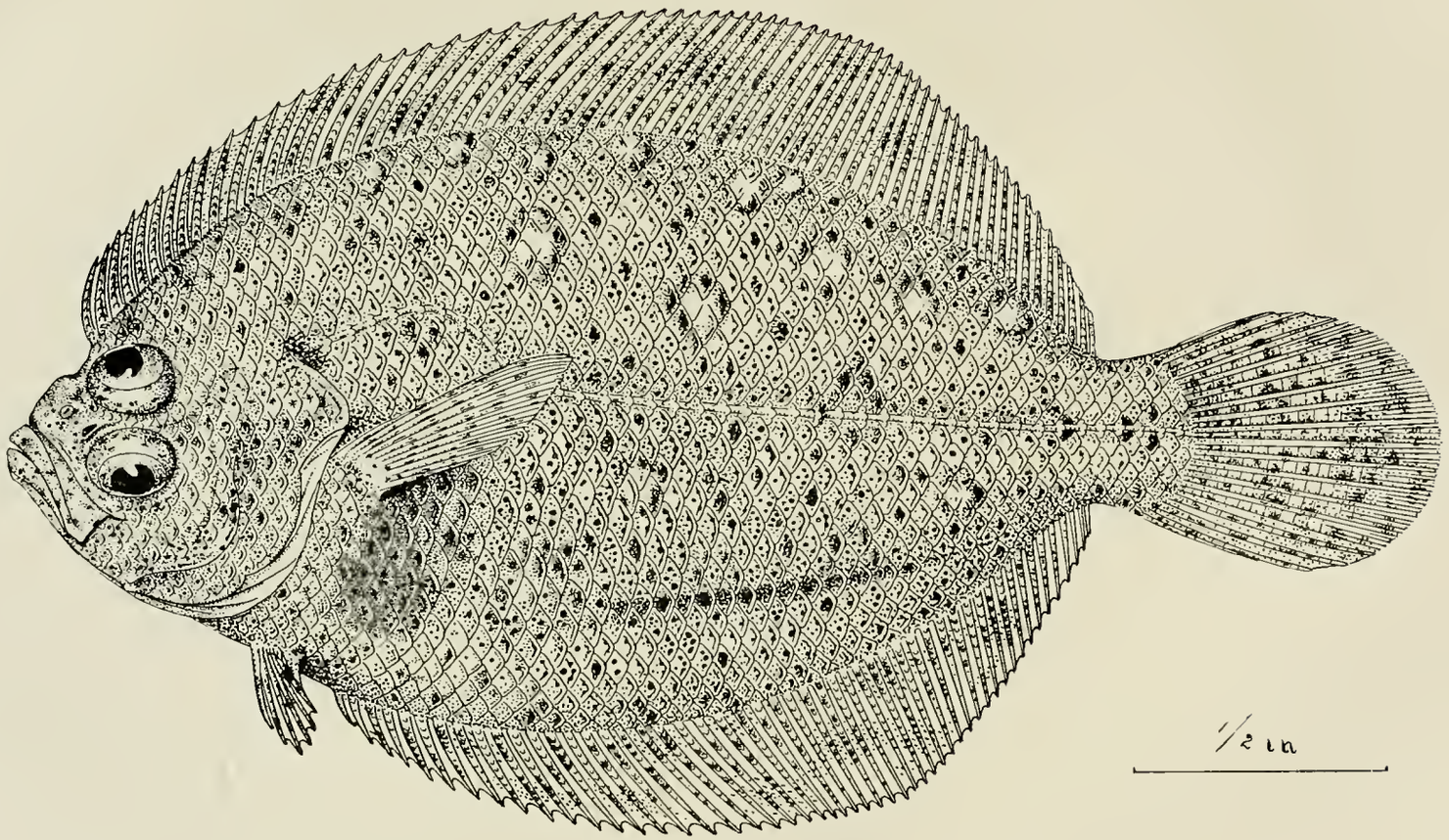


FIG. 1. *Coryphænoides bona-nox* JORDAN & THOMPSON. FIG. 1a. SCALE OF DO. FIG. 2. *Macrourus asper* GÜNTHER.



Tarphops oligolepis (BLEEKER).

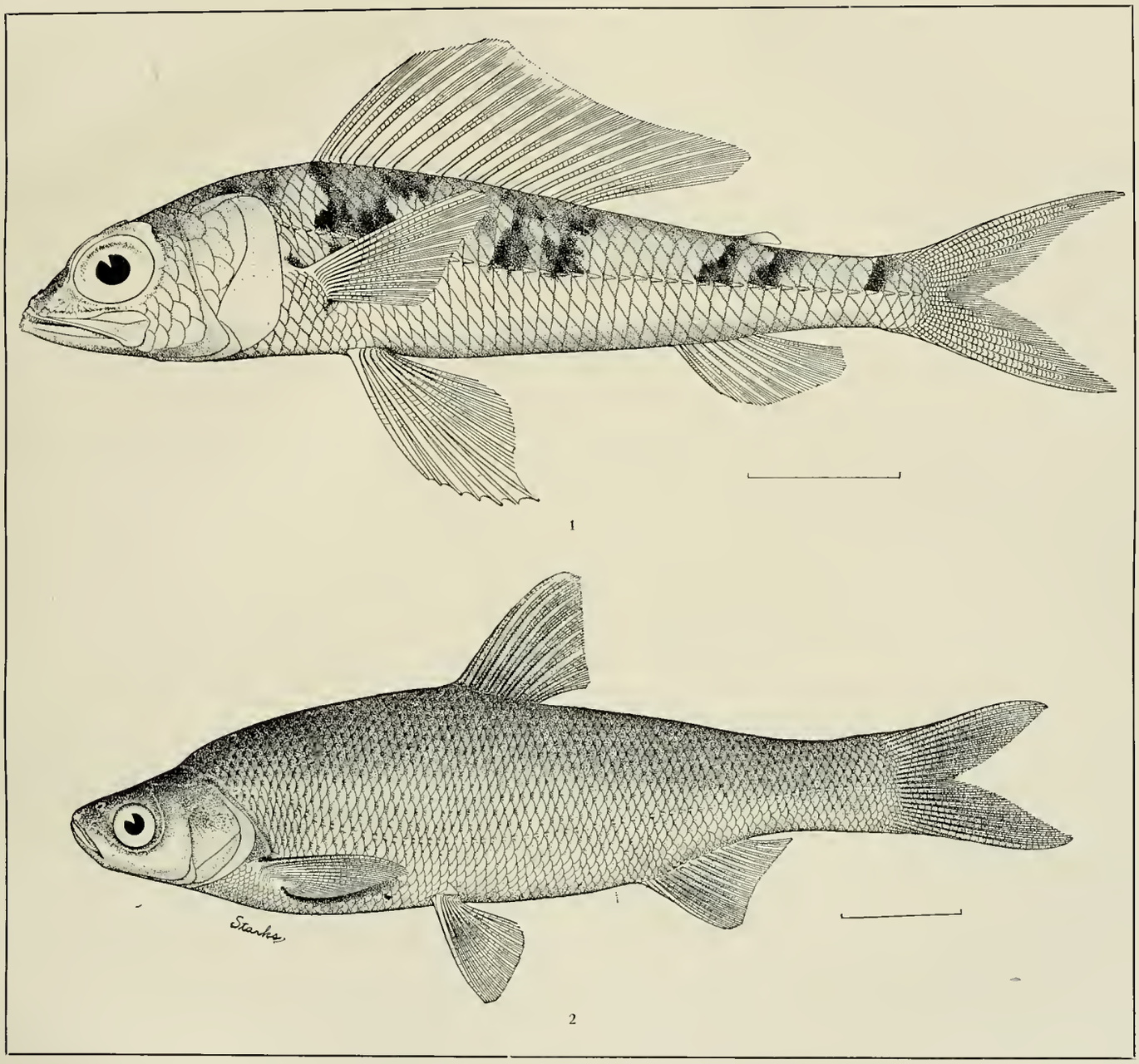


FIG. 1. *Aulopus japonicus* GÜNTHER. (FROM PROC. U. S. N. M., VOL. XXIII, PL. 32.)
FIG. 2. *Ishikauia steenackeri* (SAUVAGE). (FROM PROC. U. S. N. M., VOL. XXIII, PL. 10.)

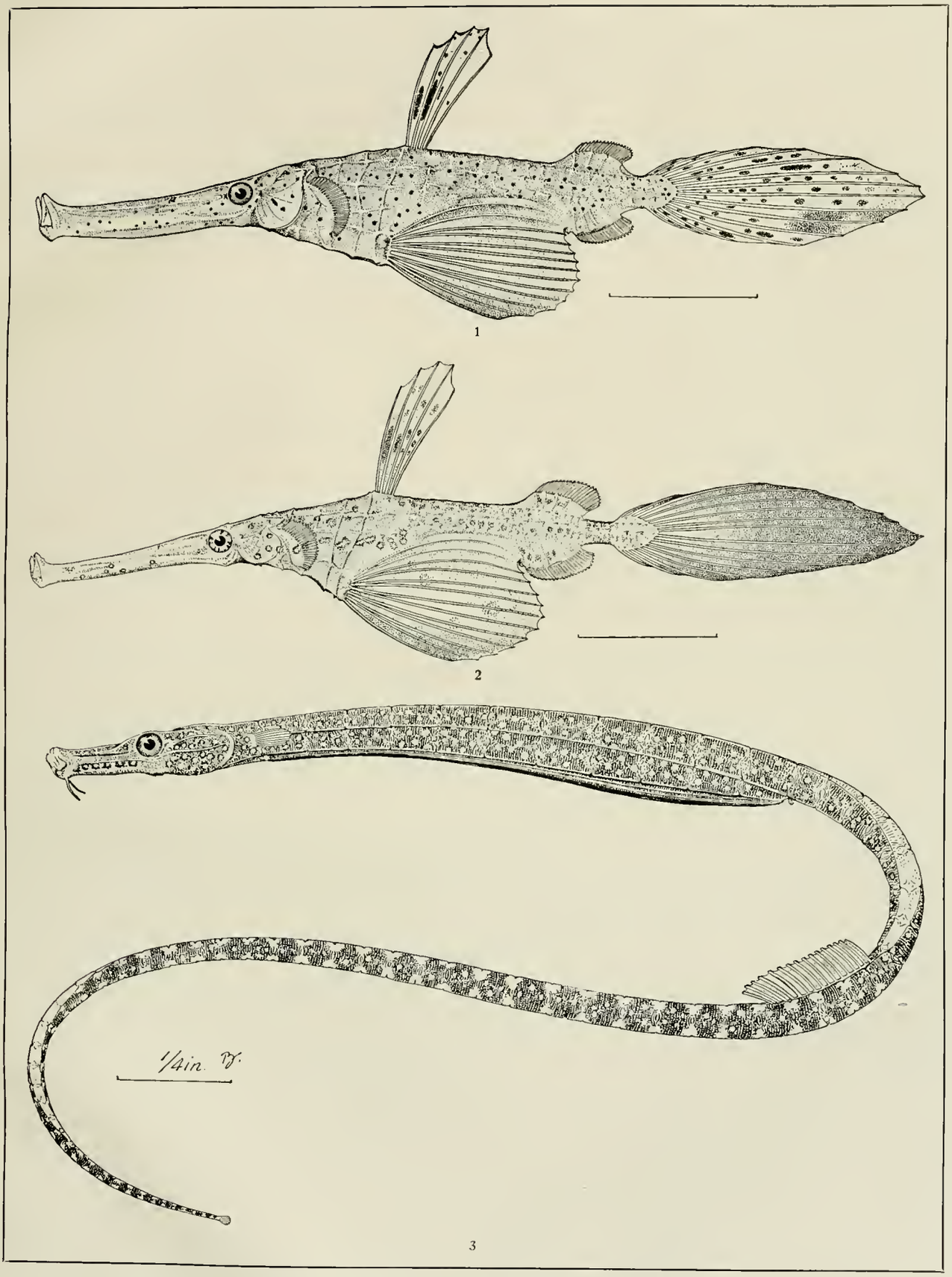


FIG. 1. *Solenostomus cyanopterus* (BLEEKER). (FROM PROC. U. S. N. M., VOL. XXIV, PL. 3.)
FIG. 2. *Solenostomus paradoxus* (PALLAS). (FROM PROC. U. S. N. M., VOL. XXIV, PL. 4.)
FIG. 3. *Urocampus rikuzenius* JORDAN & SNYDER. (FROM PROC. U. S. N. M., VOL. XXIV, PL. 7.)

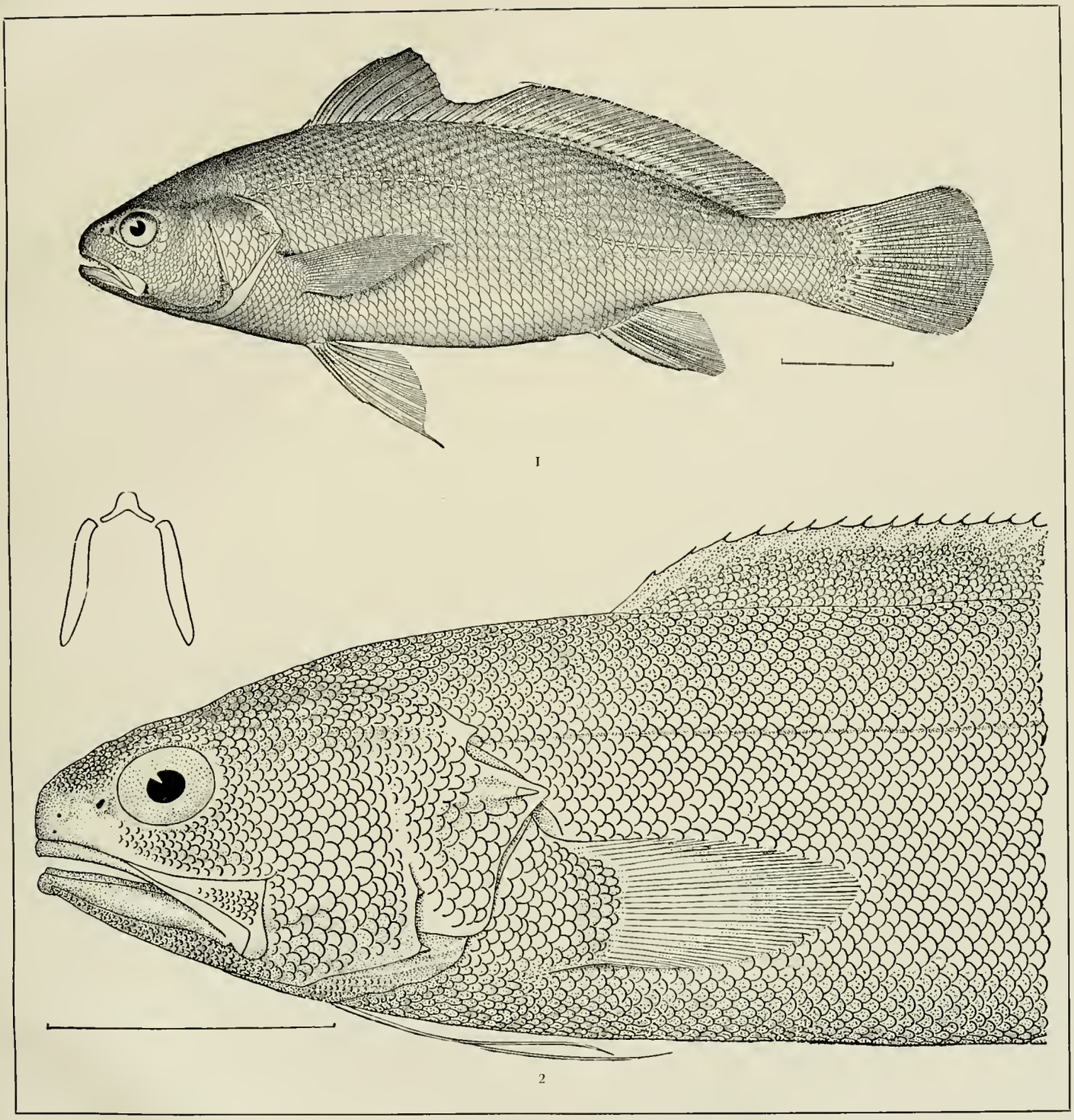


FIG. 1. *Sciænia mitsikurii* (JORDAN & SNYDER). FROM PROC. U. S. N. M., VOL. XXXIX, P. 248.)
FIG. 2. *Neobythites sivicola* (JORDAN & SNYDER). (FROM PROC. U. S. N. M., VOL. XXIII, PL. 37.)

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W. J. HOLLAND, EDITOR.

CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM

PART II. SUPPLEMENT TO THE CATALOG OF FISHES FROM THE UPPER EOCENE OF MONTE BOLCA

By C. R. EASTMAN

PITTSBURGH.

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PART II. SUPPLEMENT TO THE CATALOG OF FISHES FROM THE UPPER EOCENE OF MONTE BOLCA.

By C. R. Eastman.

(Plates XLIII–XLVIIA).

When, in the spring of the year 1910, a systematic investigation of the fossil fishes in the Carnegie Museum was undertaken by the present writer on the initiative of the Director, Dr. W. J. Holland, attention was first directed to the remarkably fine series of specimens from the Upper Eocene of Monte Bolca, near Verona, in northern Italy. What was then supposed to be the entire suite of material belonging to the Museum passed through the writer's hands, for the purpose of being identified, labeled, cataloged, and in part exhibited. This done, an account of the collection of Bolca fishes, illustrated by a number of plates, was published in the Fourth Volume of the Memoirs of the Carnegie Museum.[1]

Subsequently it was fortunately discovered that the paleichthyological resources of the Museum were greater than had been supposed. The discovery was made by Mr. O. A. Peterson, who in re-arranging a large quantity of paleontological material in storage, came across a case of fossils marked "Bayet Collection." This box was found to contain a number of unusually well preserved specimens of fishes from Monte Bolca, some of them having already served the purpose of illustrating the Veronese fauna in an earlier publication, and therefore ranking as hypotypes.[2] It can be confidently affirmed without exaggeration that in point

[1] "Catalog of Fossil Fishes in the Carnegie Museum, Part 1. Fishes from the Upper Eocene of Monte Bolca." Memoirs Carnegie Museum, Vol. IV, 1911, No. 7.

[2] Three such original exemplars, namely, *Amphistium paradoxum*, *Ephippus rhombeus*, and *Rhombus minimus*, were figured by A. B. Massalongo in his Memoir entitled *Specimen Photographicum Animalium quorundam Plantarumque Fossilium Agri Veronensis, etc.*, Verona, 1859.

of excellence of preservation, one of these hypotypes, that catalogued as No. 5305, is unsurpassed by any fossil fish from this locality which has thus far been brought to light. The following pages are supplementary to Part I of the Catalog of Fossil Fishes from Monte Bolca in the Carnegie Museum.

Subclass ELASMOBRANCHII.

Family TRYGONIDÆ.

1. **Trygon muricata** (Volta).

(Plate XLIII).

1796. *Raja muricata* G. S. Volta, Ittiolit. Beronese, p. 37, pl. ix, figs. 1, 2.
1818. *Trygonobatis vulgaris* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., xxvii, p. 336.
1835. *Trygon gazzolæ* L. Agassiz, Neues Jahrb., p. 247.
1843. *Trygon gazzolæ* L. Agassiz, Poiss. Foss., Vol. III, p. 382.
1862. *Alexandrinum* sp. R. Molin, Sitzungsber. Akad. Wiss. Wien, Vol. XLII, p. 579.
1874. *Alexandrinum molinii* A. de Zigno, Mem. R. Istit. Veneto, Vol. XVIII, p. 289, Pl. XII.
1874. *Trygon gazzolæ* A. de Zigno, *l. c.*, p. 180.
1894. *Trygon* (*Tæniura*) *muricata* O. Jaekel, "Die eocänen Selachier vom Monte Bolca," p. 142, pl. iv, fig. 32.
1904. *Trygon muricatus* C. R. Eastman, Bull. Mus. Comp. Zoöl., Vol. XLVI, p. 23.
1905. *Trygon muricatus* C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p. 8.
1911. *Trygon muricata* C. R. Eastman, Mem. Carnegie Mus., Vol. IV, No. 7, p. 352.

Type.—Nearly complete skeleton; Paris Museum of Natural History.

Two well-preserved examples of this species are figured by Jaekel in his monograph on Eocene Selachians from Monte Bolca, one of which had previously been made the type of a separate genus and species, the so-called *Alexandrinum molini* of Baron A. de Zigno. The second of Jaekel's originals was erroneously stated by that author to have been the identical specimen which is shown in Plate IX, Fig. 1, of Volta's work. In point of fact, however, Volta's type-specimens are preserved in the Paris Museum of Natural History, and were there studied by the present writer some ten years ago.

The sole character by which the genus *Alexandrinum* is said to be distinguished

from *Trygon* relates to the more distal position of the caudal spine, which arises at a distance behind the pelvic arch about equal to the maximum width of the disc. Jaekel in his memoir above referred to rightly holds that this does not constitute a valid differential character, for examination of a number of specimens shows that the relative position of the caudal sting is about the same in all.

Two examples of this Eocene ray are contained in the Bayet Collection of the Carnegie Museum, one small and preserved in counterpart, the other a beautiful specimen, larger than the type, and showing many structural details in great perfection. The small, evidently immature individual, is cataloged as No. 4521 +4521*a*, and the larger adult specimen bears the Catalog No. 4304. An illustration of the latter is shown in Plate XLIII. In this the various cartilages of the head, especially those about the mouth and scapular arch, and of those forming the axes of the pectoral fins, are clearly visible, and a number of small teeth, of the characteristic *Trygon*-type, are also seen to be attached to the palato-quadrate cartilage. An impression is preserved of the body-walls of the trunk on either side of the vertebral columns as far as the point of insertion of the caudal spine. The latter displays a median dorsal groove, bears a double series of strong posterior denticles, and has a total length of about 9 cm.

Subclass TELEOSTEI.

Order Solenichthyes.

This ordinal term, first proposed by Dr. C. T. Regan for the Centriscoids only, and afterwards (in 1909) extended so far as to include the Aulostomids and Lophobranchs, marks the present-day conception of the evolutionary history of that group of physoclistous fishes with abdominal ventrals, of which the sticklebacks form the well-known ground-type.

The Gasterosteids and their immediate allies were first united by Cope in 1887 under the comprehensive designation of Hemibranchii, and the limits of this suborder were enlarged by A. Smith Woodward in 1901 to include also the Lophobranchs of Cuvier, pursuant to the view of Kner and Steindachner (1863) that these are only extremely specialized sticklebacks with tufted gills. For this same association of Lophobranchs and Hemibranchs the new name of Thoracostei was proposed by Swinnerton in 1902, and that of Pthinobranchii was suggested for it by O. P. Hay at about the same time. Boulenger, in 1904, having attempted to show that the Lamprididæ are related to the Hemibranchs, defined the enlarged suborder which he called "Catosteomi" as consisting of the forms just named, together

with the Lophobranchs of Cuvier, and the family Pegasidæ, whose position in the system was admitted to be still somewhat doubtful.

In 1903 appeared an important paper by C. E. Starks[3] on the Osteology of the Hemibranchiate Fishes, in which he discussed the arrangement of families belonging to this division in the sense originally proposed by Cope, and calls attention to the fact that "Dr. Gill has pointed out how the tube-mouthed forms have descended in an unbroken line from *Gasterosteus* through *Spinachia* and the family Aulorhynchidæ, these constituting the superfamily Gasterostoidea" (*l. c.*, p. 622). The Danish writer H. F. E. Jungersen published in 1908 a valuable memoir, in which it was shown that the features of the Aulostomids, Centriscoids, and Lophobranchii are such as to compel us to regard these divisions as constituting a natural group. This view was supported by Regan in two papers published by him during the years 1909 and 1910, the final arrangement of families advocated by him being as follows:

Order Thoracostei Swinnerton.

"The order Thoracostei comprises the Gastrosteidæ and Aulorhynchidæ. Swinnerton[4] has shown that the dermal plate which appears as part of the coracoid is in reality a distinct element. I cannot accept Jungersen's view that these fishes belong to the Scorpænoidea, although I readily admit that the Aulostomids are more distinct from the Thoracostei than I recently considered them to be."[5]

Order Solenichthyes Regan.

Under this caption are included by Regan the Aulostomids, Centriscoids, and Lophobranchs, whose features show that they form a natural group.

A few words may be said regarding the constitution of these orders, Thoracostei and Solenichthyes. Under the first-named are now placed by Regan only the Gasterosteidæ and the Aulorhynchidæ, in which procedure he follows the example of Gill and Starks in their earlier arrangement of modern genera of sticklebacks. As early as 1871 the former of these writers had associated the families Aulorhynchidæ and Gasterosteidæ in a single division contrasting with the Aulostomids and Centriscoids, and in a subsequent review of the forms of the order in 1884 he remarks pointedly as follows:[6] "Far from being able to see any close affinity between

[3] The Shoulder-Girdle and Characteristic Osteology of the Hemibranchiate Fishes. Proc. U. S. Nat. Mus. (1903), Vol. XXV, p. 619.

[4] Quart. Journ. Micr. Sci., XLIX, 1905, p. 363.

[5] Ann. Mag. Nat. Hist., 1909 (8), Vol. III, p. 84.

[6] Gill, T. N., "On the mutual relations of the Hemibranch Fishes." Proc. Acad. Nat. Sci. Phila., 1884, p. 155.

the Aulorhynchidæ and Aulostomidæ, I am unable to appreciate any very distinctive differences from the Gasterosteidæ, and the clear affinity between *Aulorhynchus* and *Spinachia* is such that I regard the family Aulorhynchidæ simply as a convenient one at the most, and as expressing the culmination in one direction of the tendency characteristic of the order. I should be scarcely disinclined to dissent from any one who should combine the Gasterosteidæ and Aulorhynchidæ in one family."

Starks' views on the same subject are thus stated:

"*Gasterosteus* and closely related genera are the most generalized of the Hemibranchs. They are the only ones in the group having the following typical characters: Anterior vertebræ unmodified; suspensorium and mouth normal; ribs typical; post-temporal approaching the normally forked condition, and parietals present (the last a superfamily character).

" Dr. Gill has pointed out how the tube-mouthed forms have descended in an unbroken line from *Gasterosteus* through *Spinachia* and the family Aulorhynchidæ, these constituting the superfamily Gasterostoidea.

" The Gasterosteidæ and Aulorhynchidæ should perhaps be regarded as a single family, but following the lead of the above authority, they are here kept separate, though the latter family is regarded 'simply as a convenient one at the most'" (*l. c.*, p. 622).

Boulenger, in the Volume on Fishes in the Cambridge Natural History (1904), subscribes to a similar opinion. He writes:

" The genera *Aulorhynchus* and *Auliscus*, each with one species from the North Pacific, much resemble *Spinachia* in outward form and in the equal size of the anterior vertebræ, but the snout is still more produced, tubiform, and the ventral fins are formed of one spine and four soft rays. The difference which justifies their separation as a distinct family resides in the disposition of the ribs, which are flattened and anchylosed to the lateral bony shields" (p. 631).

According to the writer just quoted the extinct genus *Protaulopsis*, from the Upper Eocene of Monte Bolca, does not properly belong to the group of sticklebacks, as suggested by A. Smith Woodward, but should be associated with the Scombresocidæ. Another fossil genus, *Protosyngnathus*, from the fresh-water Tertiary of Padang, Sumatra, is made by Boulenger the type of a new family, and regarded as intermediate in position between sticklebacks and the Aulostomid division of Solenichthyes. It agrees with the former group, writes this author, " in possessing slender, free ribs, and with the latter in having the first vertebræ elongate, though to a less degree than in *Aulostoma*."

As for the constitution of the order Solenichthyes, this is made by Regan in his later publications to comprise the Aulostomids, Centriscoids, and the old Cuvierian group of Lophobranchii, or specialized sticklebacks with "tufted" gills. The family Pegasidæ is admitted by Boulenger into the same association with the foregoing, but is excluded from this order by Regan and placed in a group by themselves (order Hypostomides).

We have now to consider the position of two fossil forms, concerning which there is some difference of opinion. These are the genera *Urosphen* and *Rhamphosus* of Agassiz, both from the Eocene of Monte Bolca. They were both referred to the flute-mouths (Fistulariidæ) by Dr. Günther, but, as recognized by Dr. Gill, and following him A. Smith Woodward, "one of them is more nearly related to the Macrorhamphosidæ and Gasterosteidæ." For the one in question the new family Rhamphosidæ was established by Gill to contain it, and *Urosphen* was also made the type of an independent family. The two new families proposed by Gill in 1884 are thus defined by him:

UROSPHENIDÆ.

Hemibranchs with the first four vertebræ much elongated, a moderately elongated body, a long tubiform mouth (ventrals abdominal?, dorsal unknown), and a very large cuneiform caudal.

RHAMPHOSIDÆ.

Hemibranchs with the anterior vertebræ normal (not elongated) and separate, about twenty-two (eight abdominal and fourteen caudal) vertebræ in all, plates on the nape and shoulders only, with a tubiform mouth, subthoracic ventrals, a dorsal spine behind the nuchal armature, and the second dorsal and anal far behind and opposite.

Regarding *Urosphen*, it may be recalled that Agassiz himself recognized its intermediate position between the Aulostomids and Fistulariids. Unlike the former, *Urosphen* is scaleless, and small teeth are present in the jaws. From *Fistularia* it is distinguished chiefly by the form of the very large cuneiform caudal fin, but in other respects approaches very closely to that genus. In grouping it provisionally with recent flute-mouths, A. Smith Woodward gives the following tabulation:

SYNOPSIS OF GENERA.

No free dorsal spines; caudal fin forked, with elongated median rays; no scales..... *Fistularia.*
A series of free dorsal spines; caudal fin rhombic, without elongated ray;
small ctenoid scales present..... *Aulostoma.*
Imperfectly known, but all caudal fin-rays much elongated; no scales..... *Urosphen.*

There remains to be considered the genus *Rhamphosus*, which is placed by A. Smith Woodward among the Centriscidæ, and made by Gill the type of an independent family. Only two species are known, *R. rastrum* (Volta) and *R. biserratus* Bassani, both from the Eocene of Monte Bolca and both very rare. Nearly all writers who have noticed this genus have recognized its close agreement in the majority of structural characters with the modern *Centriscus* and *Amphisile*, as these terms are commonly used (not, however, in the sense employed by Jordan and Gilbert, Proc. U. S. Nat. Mus., 1883, Vol. V., p. 575). The differences which it presents were pointed out in the first instance by Agassiz, with the exception of one very important feature. He failed to emphasize the fact that in the fossil form the mouth is not borne at the end of an elongate, tubiform snout. And yet, at the very close of his diagnosis of the genus he writes: " Les mâchoires s'ouvrent peu et sont placées immédiatement au dessous de l'orbite."

This observation of Agassiz, which is undoubtedly correct, appears to have been overlooked by subsequent writers, all of whom ascribed to *Rhamphosus*, either directly or by implication, a character which it does not possess, namely, that of having a " snout produced in a long tube, with small, terminal, toothless mouth." In reality the condition is very different from that which is common throughout the order, and resembles that occurring in modern sword- and sail-fishes, or in the extinct *Aspidorhynchus, Hemirhynchus, Blochius*, &c., where the snout is produced in a sharp, spear-like rostrum. These are all forms in which a prominent beak results from a forward extension of the upper jaw only, but a parallel modification is found in the " Half-Beaks " or Hemiramphs, in which it is the lower jaw only that is produced. A still different modification is that observed in the African family of Mormyrids, where the pore-like mouth is at the extremity of a long, tapering proboscis. Regarding the latter group the following remark by Boulenger is of interest to us in the present connection:

" Some species of *Mormyrops* show how a form like *Gymnarchus* may have evolved out of a more typically-formed fish. Nothing is more striking than the variation in the shape of the snout within one and the same genus, and the names given to some of the species (*ovis, caballus, elephas, tamandua, numenius, ibis*) are suggestive of resemblance with the heads of various animals." (Cambridge Natural History, Fishes, p. 550.) Similar modifications of the snout are to be observed in the family Gymnotidæ.

Just as a series of stages in the formation of a tubiform snout can be traced in the stieklebacks leading from *Gasterosteus* through *Aulorhynchus* up to the flute-mouths, so in the same manner a series is traceable from the non-elongate snout of

Gymnarchus, through *Mormyrus*, up to the extremely specialized organ of *Gnathonemus*. Progressive stages in the elongation of the rostrum in scombroid fishes have been pointed out by Regan. The structural changes which have attended the formation of a beak are illustrated in the following diagrams:

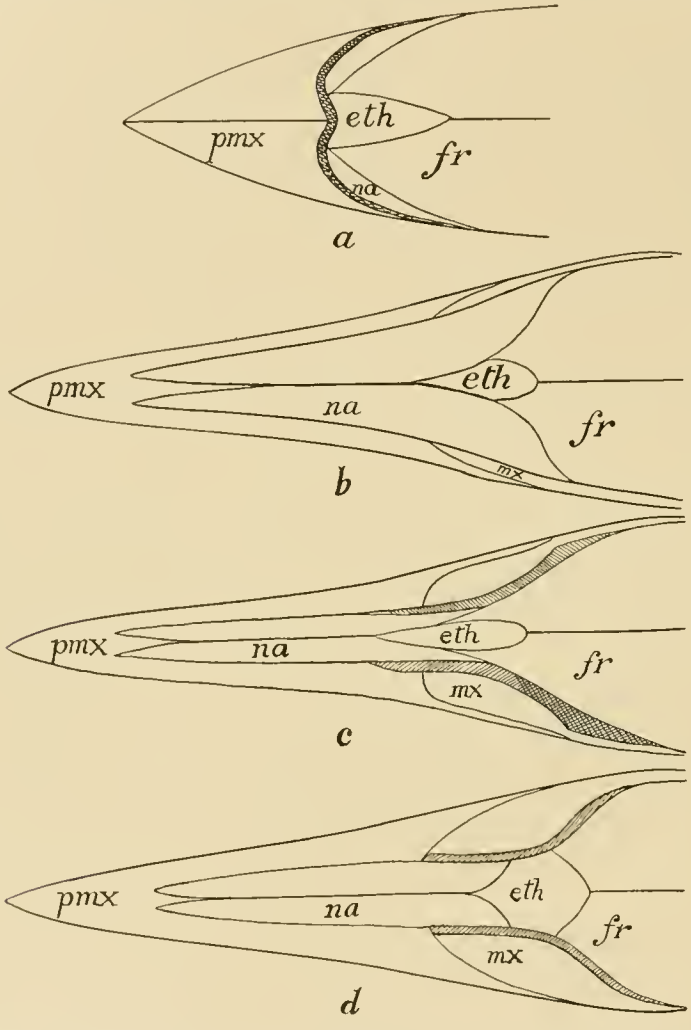


FIG. 1. Diagram showing the structure of the rostrum in *Acanthocybium* (*a*), *Histiophorus* (*b*), *Xiphias* (*c*), and *Xiphiorhynchus* (*d*). *pmx*, præmaxillary; *mx*, maxillary; *na*, nasal; *eth*, ethmoid; *fr*, frontal. (After C. T. Regan, Ann. & Mag. Nat. Hist. (8), Vol. III, 1909, p. 73).

No attempt has ever been made, so far as the present writer is aware, to explain by what means or processes the gradual formation of a rostral beak has been brought about. An interesting theory, however, has been advanced by Dr. Gregory to explain the progressive elongation of the pre-orbital region in the Syngnathidæ to form a tubiform snout with terminal jaws. The explanation given is as follows:

"The taste for minute prey to be sought by poking about in odd corners may have determined some of the peculiar specialization of the Sea-horse order. We may imagine these to have continually sought smaller and smaller food until the tiny particles came to be sucked up by the elongate muzzle. After probably passing through a stage somewhat like *Syngnathus*, but less eel-like, the ancestral Sea-horse did not need the quick-darting form of the body to capture its food or to escape enemies; hence the fan-like tail was suppressed (in *Hippocampus*), and the rapidly vibrating pectoral and dorsal fins enabled the fish to poise, humming-bird fashion, while sucking food through the tubular beak." (Ann. N. Y. Acad. Sci., Vol. XVII, 1907, p. 495).

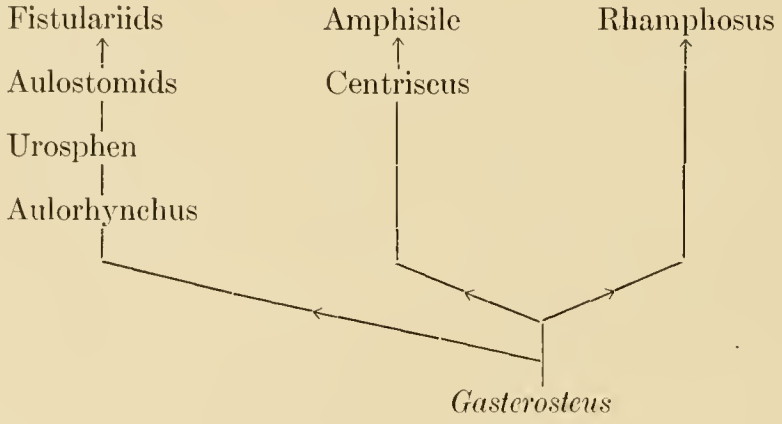
Without proceeding further into the question of origins, we wish to lay stress on the fact that among sticklebacks two distinct lines of specialization are traceable as regards the conformation of the region between the orbit and the mouth. Progressive modification in one direction leads to the pushing forward of this whole region, the jaw parts being carried along in this facial elongation and the mouth retaining its terminal position. An evolutionary series of Gasterosteiformes, showing gradual transformation with respect to these characters, was first worked out by Dr. Theodore N. Gill. And it is to be noted that at the same time that the snout was becoming elongated into a slender tube, scales over the body were becoming progressively superseded by dermal armor. The armament is first indicated in the form of bony scutes arranged in rows along the back and flanks, and finally culminates in the cuirass of *Amphisile*, which is fused with the enlarged ribs and other portions of the endoskeleton (*cf.* Gregory, *l. c.*, p. 493).

The second line of progressive modification culminates in the formation of a rostral beak recalling that found in certain Xiphiiformes (*Histiophorus*, *Blochius*, etc.), though the mouth is situated ventrally and but little in advance of the orbits. This series may also be supposed to begin with *Gasterosteus* or its immediate prototype, and leads through stages which are not recorded in paleontology up to the longirostrate type of which *Rhamphosus* is the only known example.

Now the interesting thing to note is that this second evolutionary series is not only specialized in the direction of acquiring a sword-like rostrum, but it also exhibits the unfolding of characters which are progressively displayed in the parallel evolutionary series. For convenience we may distinguish these as (1) the tube-snout, and (2), the rostrate series, both having *Gasterosteus* as a common starting-point.

The evolutionary changes that have taken place appear to have proceeded in the following manner. A generalized or "synthetic type," to use Agassiz's phrase,

contains within itself certain potentialities of continuous variation. It is charged, so to speak, with a complex of latent characteristics. One set of these is that which terminates in an elongated tubiform snout, the other in the development of a peculiar kind of dermal armor, including a long and slender dorsal fin-spine. In the tube-snout evolutionary series the gradual elaboration of these two sets of characters, which may be supposed to be resident potentially in *Gasterosteus*, goes hand in hand; and thus we find that *Centriscus* has both a tubular snout and is provided with dermal armor and a well-developed dorsal fin-spine. But in the rostrate series one of these sets of characters is suppressed, no tubular snout being developed. The second group of characters which was potentially present in *Gasterosteus* is developed in precisely the same fashion as in the Centriscoids, with the result that in *Rhamphosus* we find a body-armor paralleling that in *Centriscus*, and a remarkably similar dorsal fin-spine. The divergence in forms with reference to the splitting up of the original complex of characters might be illustrated by the following scheme:



Family Rhamphosidæ Gill (*emend.*).

Solenichthyes with *Gasterosteus*-like form of body, the anterior vertebræ discrete and not elongated, about twenty-two (eight abdominal and eighteen caudal) vertebræ in all; dermal plates on the nape and shoulder-region only; a single, elongate dorsal spine arising from the hinder end of the nuchal armature. Mouth small, and placed as in *Gasterosteus*, but the upper portion of the head produced in an elongate rostrum. Ventral fins subthoracic, the second dorsal and anal remote and opposite.

2. **Rhamphosus rastrum** (Volta).

(Pl. XLIV, Figs. 1–3).

1796. *Uranoscopus rastrum* G. S. Volta, Ittiolit. Veronese, p. 22, pl. V, fig. 4.

1796. *Centriscus* G. S. Volta, *ibid.*, pl. LXXV, fig. 1 (*errore*).

1818. *Centriscus aculeatus* H. D. de Blainville, Nouv. Diet. d'Hist. Nat., Vol. XXVII, p. 339.

1835. *Rhamphosus aculeatus* L. Agassiz, Neues Jahrb., p. 291 (name only).

1839–42. *Rhamphosus aculeatus* L. Agassiz, Poiss., Foss. Vol. IV, p. 270, pl. XXXII, fig. 7.

1888. *Rhamphosus aculeatus* L. Vaillant, Expéd. Scient. Travailleur et Talisman, Poissons, p. 339.

1898. *Rhamphosus aculeatus* F. Bassani, Palæntogr. Italica, Vol. III, p. 82; pl. IX, fig. 4.

1901. *Rhamphosus aculeatus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Part IV, p. 378.

1905. *Rhamphosus rastrum* C. R. Eastman, Mém. Soc. Géol. France, No. 34, p. 20.

1911. *Rhamphosus aculeatus* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 362.

Type.—Nearly complete skeleton; Paris Museum of Natural History.

The genotype, which attains a length of about 14 cm. Maximum depth of body occurring in about the region of the pectoral arch, behind which the trunk is slender and gradually tapering. Distance between the orbit and extremity of the elongated rostrum equal to that between the orbit and origin of the second dorsal fin, and equalling also the length of the single dorsal spine. The latter is slender, acuminate, nearly rectilinear, and posteriorly denticulated. The beak also bears a series of minute denticles. Dorsal and anal fins equal and directly opposed, each with nine rays, and caudal with sixteen rays. Scales very minute, having the form of dermal granulations or papillæ.

This is an extremely rare form, only two examples being found in the Paris Museum and a small imperfect one in the British Museum. One fully grown and three immature individuals are contained in the collection of the Carnegie Museum, being cataloged as follows: 5328, 5310 + 5310*a*, 5312, and 4213 + 4213*a*. Two of these are figured in the accompanying plates.

Family Urosphenidæ Gill.

Solenichthyes with the first four vertebræ much elongate, a moderately elongated and slender body, a long tubiform snout with terminal mouth, second dorsal and anal remote, similar and opposite, caudal fin relatively large, vertebræ between fifty and sixty in number; scales absent.

Genus Urosphen Agassiz.

No new characters can be added to the generic diagnosis of this genus, but a further study of one nearly complete skeleton in the collection warrants the establishment of a new species, the description of which immediately follows.

3. Urosphen attenuata sp. nov.

1911. *Urosphen dubia* Eastman, Mem. Carnegie Museum, Vol. IV, No. 7, p. 361, Pl. XCVI, fig. 2.

Type.—Nearly complete fish; Carnegie Museum (Cat. No. 4499).

A small species attaining a length of about 20 cm. having about the same proportions as the type of *U. dubia*, but more vertically compressed, and differing in the conformation of the caudal fin. This is intermediate in character between the caudal fin of *U. dubia*, which is cuneiform with all of the rays gradually increasing in elongation above and below axially, or medianwards, and that of Fistulariids in which two axial rays are excessively elongated. The neural and hæmal spines of the last vertebral centrum are expanded into fan-shaped laminæ medially

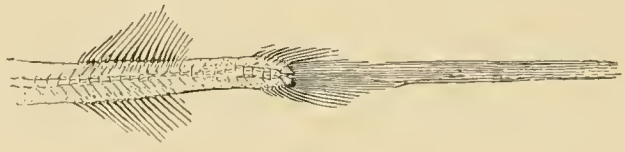


Fig. 2. Tail of *Urosphen attenuata* Eastman. × ½. C. M. Cat. Foss. Fishes, No. 4499.

in contact and together forming a urostyle,[7] which supports in all six slender, greatly elongated and closely apposed caudal fin rays, half the number being epiaxial and half hypaxial (see Fig. 2).

In addition, a series of ten short rays, increasing gradually in length from the anteriormost onwards until about the fifth, after which all are of uniform length, arise from the dorsal and ventral margins at the posterior extremity of the body, being supported by the neural and hæmal spines of the last five vertebræ. The dorsal and anal fins are remote, similar, and opposite, the former with eighteen rays, and the latter with twenty. The trunk and head are vertically much compressed, and the small, terminal mouth is provided with minute conical teeth. In the type-specimen the undigested skeletal remains of a small teleost are seen in the forward part of the intestinal tract. The holotype has already been figured in the Memoirs (1911) under the name of *U. dubia*.

[7] Reference may be made here to the writings of R. H. Whitehouse (Proc. Roy. Soc., Vol. 72 B, 1909, p. 139), and C. T. Regan (Ann. Mag. Nat. Hist., (8) Vol. V, 1910, p. 531) on the caudal fin of Clupeoids, and the Teleostean urostyle.

The last-named author remarks (*l. c.*, p. 533):

"A comparative study leaves no room for doubt that in many cases the urostyle is merely the result of anchylosis of the uroneurals and that centra take little or no part in its formation, and I do not think that there are any fishes in which a urostyle has been formed simply by anchylosis of posterior centra; but that is a matter which requires further investigation."

Order Berycomorphi.

The view is commonly entertained that the fishes belonging to this order are very generalized, as is shown by such characters as the large number of pelvic fin-rays, and the persistence of the pneumatic duct in certain genera, as well as the widespread distribution and importance of the group so long ago as the Cretaceous. The family Berycidæ is represented in the Upper Eocene fauna of Monte Bolca by two genera, *Holocentrum* and *Myripristis*, remains of which are not uncommon. The typical species of these genera, which are represented in the collections of the Museum, have already been considered in the Catalog of Fossil Fishes published in Volume IV of the Memoirs of this institution.

Order Heterosomata.

Physoclistic Teleosts with asymmetrical cranium and strongly compressed body, the precaudal region short; pelvic bones directly attached to the cleithra (clavicles); fins without spines.

The Heterosomata, or Flat-fishes, are to be regarded as aberrant, strongly compressed Pereiformes or a derivative from that stock, instead of being asymmetrical Gadoids, as was formerly supposed. They differ from all other fishes in having an asymmetrical cranium; both eyes are on one side in the adult, this side being uppermost and pigmented, whilst the lower or eyeless side is usually devoid of pigment.

Boulenger has expressed the view that the Upper Eocene genus *Amphistium* is allied to the symmetrical ancestor of the flat-fishes, and this opinion is also shared by Regan, who, however, regards *Amphistium* as a Percoid not far removed from *Platax*, and approaching in some respects to the existing *Psettus*. As true Soles accompany *Amphistium* in the Upper Eocene, the ancestral form from which flat-fishes are derived must have been evolved at a still earlier period. Valuable descriptions and figures of the crania in flat-fishes were published by Traquair[8] in 1865, and various classificatory schemes have been proposed for the group by recent writers.[9]

Suborder Pleuronectoidea.

Dorsal fin extending forward on the head at least to above the eye; all the fin-rays articulated, each pelvic fin of six or fewer rays. No supramaxillary bone; no palatine teeth; lower edge of urohyal deeply emarginate, so that the bone appears

[8] Trans. Linn. Soc., Vol. XXV, 1865, pp. 263–296.

[9] Kyle, H. M., Rept. Fisheries Board Scotland, Vol. XVIII, 1900, pp. 335–368.—Boulenger, G. A., Cambridge Natural History, Fishes, 1904.—Regan, C. T., Origin and Evolution of the Teleostean Fishes of the order Heterosomata. Ann. Mag. Nat. Hist., (8), Vol. VI, 1910, pp. 484–496.

forked. On each side is a single posteleithrum or none. Vertebræ never fewer than twenty-eight (9+19).

Jordan and Evermann, in their Catalogue of North American Fishes, recognize only the two families, Pleuronectidæ and Soleidæ, but in the more recent scheme of Regan there is considerable further subdivision. Among fossil forms, *Solea* proper first appears in the Lower Miocene, and a species commonly assigned to "Rhombus" (in the Cuvierian sense) is present already in the Upper Eocene. The term *Rhombus* was, however, applied in 1800 by Lacépède to a genus of Butterfishes, or seven years before its employment by Cuvier for the turbot; hence modern usage requires it to be replaced among flat-fishes by the term *Bothus*, proposed in 1810 by Rafinesque.

Not all of the characters pertaining to the recent *Bothus* can be observed in the Eocene forms, and in particular, fewer vertebræ are present in the latter, the number being not more than nine abdominal and nineteen caudal. Hence it is desirable to designate the fossil species commonly referred to "*Rhombus*" by a new generic name. The term *Eobothus* may be conveniently employed for this purpose.

Eobothus, nom. nov.

In general like the existing *Bothus*, but with not more than nine abdominal and nineteen caudal vertebræ. Mouth wide, the jaws and dentition being nearly equally developed on both sides; a narrow band of minute, conical teeth on the margin of the jaws. Abdominal vertebræ with broad transverse processes and very small, delicate ribs; epi- and hypaxial spines at base of caudal fin somewhat expanded, but not fused together into laminar plates. Both pairs of fins present; dorsal arising just over the eye; caudal fins separate, rounded behind. Scales small and thin, showing under the lens very fine parallel, more or less longitudinal or obliquely directed striæ.

4. **Eobothus minimus** (Agassiz).

(Pl. XLV, Figs. 1–2).

1796. *Pleuronectes quadratulus* G. S. Volta, Ittiolit. Veronese, p. 260, pl. LXIII, fig. 3 (*errore*).

1835. *Rhombus minimus* L. Agassiz, Neues Jahrb., p. 301 (name only).

1839–42. *Rhombus minimus* L. Agassiz, Poiss. Foss., Vol. IV, p. 289, pl. XXXIV, fig. 1.

1859. *Rhombus minimus* A. B. Massalongo, Specimen Photogr. Anim. Foss. Agr. Veron., p. 36, pl. XIII, fig. 1.

1901. *Rhombus minimus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., pt. IV, p. 607.

1911. *Rhombus minimus* C. R. Eastman, Mem. Car. Mus., Vol. IV, p. 383.

Type.—Nearly complete fish; Paleontological Museum, Munich.

"A very small species, attaining a length of about 10 cm. Length of head with opercular apparatus contained two and a half times in the length from the pectoral arch to the base of the caudal fin; maximum depth of trunk about four-fifths of latter measure. Vertebræ ten to twelve in the abdominal, twenty in the caudal region. Dorsal and anal fins deepest in their middle portion, the former with about sixty-five, the latter with about forty-five rays; both these fins terminating very close to the caudal, which comprises seventeen to nineteen rays. Small scales well developed, apparently cycloid" (A. S. Woodward).

Two additional examples of this early species of flat-fish, both of them beautifully preserved, have been found in the material belonging to the Carnegie Museum. These bear the catalog numbers 5313, and 5314 + 5314*a*. Affixed to the former of these is an original label in unknown handwriting, stating that this is the original specimen figured by Massalongo in Plate XIII, fig. 1, of the Memoir published by him in 1859.

These specimens are remarkable for the distinctness with which nearly all of the fine structural characters are displayed, and yet little can be added to the full and accurate description of the skeleton as given by Agassiz in his "Recherches." This author gives a table showing the arrangement of supports for the dorsal and anal fins with reference to the neural and hæmal spines. Some variation is to be noted in this respect, and one observes also that as a rule the extremities of these elements are not usually in contact, as represented in the figure of the holotype given by Agassiz. In both of the specimens belonging to the Carnegie Museum now under discussion the first two neurapophyses are much expanded laterally, delicate ribs are seen, the paired fins are well shown, and a number of minute teeth may be recognized. There appears to be a dense squamation, all of the scales being finely striated.

It is interesting to note that Agassiz, in commenting on the scale-characters of Pleuronectids, remarked upon their resemblance to those of Chætodonts (Poiss. Foss. IV, p. 288); and again, in the description of the genus *Macrostoma* (*ibid.*, p. 260), argued at length upon the close approximation between Pleuronectids of the *Psettus* type and laterally compressed Chætodonts like *Platax*.

Order Percomorphi.

Physoclistic Teleosts with symmetrical cranium; pelvic bones directly attached to the cleithra; each pelvic fin composed of one spinous and five soft rays or still further reduced; no orbitosphenoid, and no bony stay for the pre-operculum.

Under this order are comprised in the more recent classifications of Regan the following six suborders: Percoidei, Scombrodei, Kurtodei, Gobioidei, Blennioidei, and Scorpænoidei.

Suborder Percoidei.

Family Carangidæ.

Genus Amphistium Agassiz.

Trunk much deepened, and head short and deep, with rather large supra-occipital crest. Eye large; cleft of mouth of moderate size and directed upward; teeth minute or absent. Paired fins small, the pelvic pair inserted in advance of pectorals; dorsal fin not much elevated, extending along the greater part of the back, with three or four feeble anterior spines; anal fin almost or quite as much extended as the dorsal, with three or four feeble anterior spines; caudal fin rounded. Scales very small, none enlarged or thickened.

5. **Amphistium paradoxum** Agassiz.

1796. *Pleuronectes platessa* G. S. Volta, Ittiolit. Veronese, p. 179, Pl. XLIV, fig. 1 (*errore*).

1818. *Pleuronectes platessa* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 357 (*errore*).

1835. *Amphistium paradoxum* L. Agassiz, Neues Jahrb., p. 294 (name only).

1834–44. *Amphistium paradoxum* L. Agassiz, Poiss. Foss., Vol. V, Pt. 1, p. 44, Pl. XIII.

1905. *Amphistium paradoxum* C. R. Eastman, Mém. Soc. Géol. France, No. 34, p. 24.

Type.—Nearly complete fish; Museum of Natural History, Paris.

The genotype, attaining a length of about 20 cm. Length of head with opercular apparatus somewhat exceeding half the maximum depth of the trunk, which is contained twice or slightly less in the total length of the base of the caudal fin. Vertebral column composed of nine abdominal and fifteen caudal vertebræ, all abbreviate and massive. Dorsal and anal fins gently rounded and equally elevated, each with from twenty-one to twenty-three stout, articulated, and divided rays.

This rare and interesting species is considered by Boulenger "to realize in

every respect the prototype of the Pleuronectidæ before they had assumed the asymmetry which characterizes them as a group." By the author just named this supposed ancestral flat-fish is placed in close association with the Zeidæ, from which family it differs, however, in the smaller number of vertebræ, and in having the dorsal and anal spines more reduced, adnate, and continuous with the series of soft rays. A copy of Boulenger's restoration of this species is given in figure 3. It

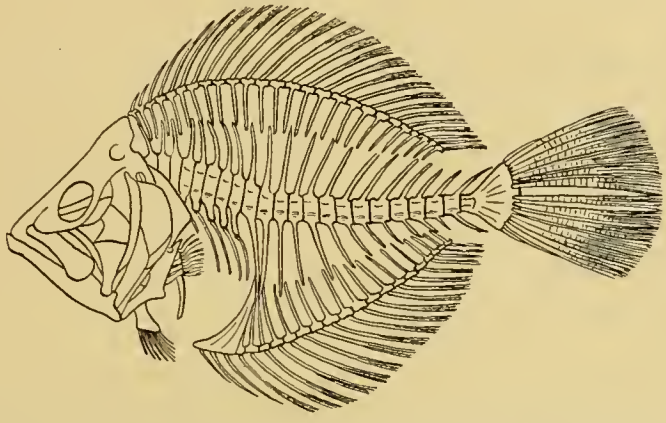


FIG. 3. *Amphistium paradoxum* Agassiz. Upper Eocene, Monte Bolca, Italy. Skeleton as restored by Boulenger, about one-half the natural size. (*Cf.* Mem. Carnegie Museum, Vol. IV, p. 383).

is based upon two nearly complete specimens preserved in the British Museum of Natural History and these two specimens afterwards furnished Dr. Regan the basis for the following statement:

"I much more readily subscribe to Boulenger's view that the Upper Eocene *Amphistium* is allied to the symmetrical ancestor of the flat-fishes, for in my opinion this fish is a Percoid, which should probably be placed in the family Scorpididæ near the existing *Psettus*, or may perhaps be related to *Platax*. Thanks to the courtesy of Dr. A. Smith Woodward, I have been able to examine the two examples of *Amphistium paradoxum* in the British Museum. The caudal fin has seventeen principal rays above and below (Agassiz gives the formula for this fin: 6. I. 8; 7. I. 2); the pelvic fin, preserved only in the Monte Bolca specimen, is formed of a spine, and, in my opinion, five soft rays, for I cannot see a greater number inserted on the pelvic bone which lies uppermost, the outlines of which are fairly distinct.

"Boulenger's restoration shows several features of *Psettodes* or *Zeus* which I am unable to see in the fossils; thus he shows the lower jaw nearly as long as the head and the pre-operculum vertical and scarcely curved, whereas the lower jaw appears to be only a little more than half the length of the head, and the pre-operculum to have a distinct lower limb; also the origin of the anal fin is not so far

forward in the actual fossils as it is in the restoration." (Ann. Mag. Nat. Hist., 1910 (8) Vol. VI, p. 486.)

This species is not represented in the collection of the Carnegie Museum, but there has sometimes been included under it a closely allied form which is here considered as specifically distinct, and the discussion of which immediately follows.

6. **Amphistium bozzianum** Massalongo.

(Plate XLV, Fig. 4.)

1859. *Amphistium bozzianum* A. B. Massalongo, Spec. Photogr. Anim. Foss. Agr. Veron., p. 37, pl. XIII, fig. 2.

1887. *Amphistium bozzianum* A. de Zigno, Mem. R. Istit. Veneto, Vol. XXIII, p. 14.

1901. *Amphistium bozzianum* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Vol. IV, p. 435.

Type.—Nearly complete fish; Carnegie Museum. (Cat. No. 5308).

This species appears to be known only by the original holotype, which is now the property of the Carnegie Museum. It is of relatively small size, measuring only about 5 cm. in length from the extremity of the snout to the base of the caudal fin. By Belotti it was regarded as an immature example of *A. paradoxum* Agassiz, but its claims to recognition as a distinct species were re-affirmed in 1879 by Baron de Zigno, and his views are fully confirmed by the present writer's examination of the holotype.

This latter has a less deep body than *A. paradoxum*, the vertebral column and its neural and hæmal arches are more delicately constructed, the caudal fin is relatively smaller and the dorsal and anal more elevated, and the number of dorsal fin-rays is greater (twenty-eight as compared with twenty-three) than in *A. paradoxum*. It is to be noted that the paired fins and bones of the head are much more clearly displayed in Massalongo's holotype than in the original of *A. paradoxum* figured by Agassiz.

Genus Ductor Agassiz.

7. **Ductor leptosomus** Agassiz.

1796. *Callionymus vestenæ* G. S. Volta, Ittiolit. Veronese, p. 140, pl. XXXII, fig. 2 (*errore*).

1796. *Gobius smyrensis* G. S. Volta, *ibid.*, p. 241, Pl. LVIII, fig. 2 (*errore*).

1818. *Callionymus vestinæ* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 359.

1818. *Gobius smyrensis* H. D. de Blainville, *ibid.*, p. 358.

1834. *Ductor leptosomus* L. Agassiz, Verhandl. Ges. vaterländ. Mus. Böhmen, p. 66 (name only).

1835. *Ductor leptosomus* L. Agassiz, Neues Jahrb., p. 293 (name only).
1834–44. *Ductor leptosomus* L. Agassiz, Poiss. Foss., Vol. V, Pt. 1, p. 53, pl. XII.
1876. *Ductor leptosomus* F. Bassani, Atti. Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 184.
1901. *Ductor leptosomus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. IV, p. 448.
1911. *Ductor leptosomus* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 369.

Type.—Imperfect fish; Museum of Natural History, Paris.

Besides the examples of this species already cataloged as part of the Bayet Collection in the Carnegie Museum, an additional specimen, preserved in counterpart, is contained in the material upon which report is now being made. It is cataloged as No. 5315+5315*a*.

Genus Zanclus Cuvier and Valenciennes.

8. **Zanclus brevirostris** Agassiz.

1796. *Chætodon canescens* G. S. Volta, Ittiolit. Veronese, Pl. XXVI, fig. 2 (*errore*).
1842. *Zanclus brevirostris* L. Agassiz, Poiss. Foss., Vol. IV, p. 236, pl. XXXVIV.
1911. *Zanclus brevirostris* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 372.

Type.—Nearly complete fish; Museum of Natural History, Paris.

Among the additional suite of specimens that has recently come to light is an excellently preserved representative of this species, cataloged as No. 5306. It proves to be the left-hand counterpart of the example already cataloged as No. 4415. This specimen bears two original MS. labels in an unknown hand, reading as follows: " Dono di Eugenio Sardagna, Venezia, 18 Nr. 1888 (*ex* Galleria Manfron)." " *Chætodon canescens* Volta, Ittiol. Veron; Tav. 26, fig. 2."

Family Chætodontidæ.

Genus Pygæus Agassiz.

9. **Pygæus coleanus** Agassiz.

1834–42. *Pygæus coleanus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 16–256, Pl. XLIV, fig. 5.
1838–42. *Pygæus egertoni* L. Agassiz, *ibid.*, p. 257 (imperfect fish, British Museum).
1838–42. *Pygæus gibbus* L. Agassiz, *ibid.*, p. 257 (distorted fish, British Museum).
1901. *Pygæus coleanus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. IV, p. 557.

Type.—Imperfect fish; British Museum.

This is an imperfectly known small Chætodont, of which nearly all of the

specimens, so far brought to light, have been more or less distorted. One such, preserved in counterpart and cataloged as No. 5317+5317*a*, is contained in the lot of material from Monte Bolca, which originally formed part of the Bayet Collection. Two others, smaller, but better preserved, are cataloged as Nos. 5322 and 5323. There are also preserved in the same collection two or three examples of an allied form from the Lower Miocene of Chiavon, Vicentin, in northern Italy.

Genus Ephippus Cuvier.

10. **Ephippus rhombus** (Blainville).

(Plate XLVI, Fig. 1).

1796. *Chætodon mesoleucus* G. S. Volta, Ittiolit. Veronese, p. 41, Pl. X, fig. 1 (*errore*).

1796. *Chætodon chirurgus* G. S. Volta, *ibid.*, p. 177, Pl. XLIII (*errore*).

1818. *Chætodon chirurgus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 353.

1818. *Chætodon rhombus* H. D. de Blainville, *ibid.*, p. 353.

1823. *Chætodon rhomboides* J. F. Krüger, Gesch. Urwelt, Pt. II, p. 671.

1842–44. *Ephippus longipennis* L. Agassiz, Poiss. Foss., Vol. IV, pp. 15, 225, Pl. XL.

1859. *Ephippus longipennis* A. B. Massalongo, Spec. Photogr. Anim. Foss. Agr. Veron., p. 34, Pl. IX.

1876. *Ephippus longipennis* F. Bassani, Att. Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 179.

1886. *Ephippus longipennis* W. Szajnocha, Pamiet. Wydz. matem-przr. Akad. Umiejet. Krakow, Vol. XII, p. 108, Pls. II, III.

1901. *Ephippus rhombus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 559.

1911. *Ephippus rhombus* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 380, Pl. XCII, fig. 2.

Type.—Imperfect fish; Paris Museum of Nat. History.

One is certainly safe in saying that no more perfectly preserved fish from the Monte Bolca locality has yet been made known than the splendid example figured by Massalongo in Plate IX of his work published in 1859. The identical specimen now forms part of the Bayet Collection in the Carnegie Museum, and is cataloged as No. 5305. It bears an original MS. label in an unknown hand reading: "E l'esemplare figurato nella tav. IX. dello Specimen Photogr. di Massalongo."

Family Sparidæ.

Genus Sparnodus Agassiz.

11. Sparnodus vulgaris (Blainville).

The synonymy of this species is very long, and need not be given here, as no particularly noteworthy example has been added to the collection since the Catalog of Monte Bolca Fishes in the Carnegie Museum was published two years ago. However, among the material recently brought to light is one very curious specimen which is clearly of composite nature, being made up of portions of various individuals artfully pieced together, though not in accordance with the teachings of comparative anatomy. It is catalogued as No. 5330, and is worthy of preservation in its present state as a curiosity, or monstrosity.

Family Labridæ (Wrasses).

Narial opening double on each side. Marginal teeth prehensile; vomer and palatines toothless; lower pharyngeal bones (rarely also upper pharyngeals) fused together. Spinous portion of dorsal fin at least as much extended as articulated portion; anal fin with two to six spines, nearly equal to, and opposite, the hinder dorsal fin. Scales usually cycloid, rarely feebly ctenoid.

Existing Wrasses are brilliantly colored marine fishes with thick lips, strong pointed teeth on the jaws, and conical or tubercular teeth on the pharyngeals. An able discussion of the group is that by Dr. D. S. Jordan, entitled "A Review of the Labroid Fishes of America and Europe," to be found in the Report of the U. S. Fish Commission for 1887 (1891), pp. 559–699.

In the paper of Dr. Jordan just referred to the procedure was adopted of uniting the genus *Crenilabrus* of Cuvier and Valenciennes with the earlier described *Symphodus* of Rafinesque.

At a later period, however, the distinguished ichthyologist in question found reason for changing his opinion, and for maintaining *Crenilabrus* and *Symphodus* as distinct genera. Thus, in a note published in *Science* for August 19, 1904, (Vol. XX, p. 245), he writes as follows:

"I should now separate *Crenilabrus* C. and V. as a valid genus from *Symphodus* Raf. (= *Coricus* C. & V.) with which I united it in 1891. *Symphodus scina* has the general characters of *Crenilabrus*, the serrated pre-opercle and other features, but it has the snout strongly produced, giving a concave profile, a matter probably worthy of generic distinction. *Crenilabrus* like *Symphodus* has thirteen or fifteen dorsal spines, and thirty-one to thirty-three vertebræ. I do not see how *C. szajnochæ* can be properly placed in it, as these numbers are fairly constant within the same genus. *C. szajnochæ* should form the type of a new genus."

EOLABROIDES gen. nov.

An extinct genus allied to the existing *Labrus, Crenilabrus, Symphodus,* etc., and known thus far only by the type species, which was originally described under the name of *Crenilabrus szajnochæ* Zigno. Adopting the suggestion of Dr. D. S. Jordan, it may be more properly considered as the type of a distinct genus, for which the new name of *Eolabroides* is proposed at the suggestion of the veteran naturalist and supreme authority in American ichthyology, Dr. Theodore N. Gill of Washington.

Diagnosis.—An extinct genus, known only by the type species, much resembling the existing *Labrus,* but with fewer vertebræ, and an extended dorsal fin with more than twice as many soft rays as in the living genus. Scales not extending over the opercular apparatus and cheeks.

12. **Eolabroides szajnochæ** (A. de Zigno).

(Pl. XLVI, Figs. 2–3).

1887. *Crenilabrus szajnochæ* A. de Zigno, Mem. R. Istit. Veneto, Vol. XXIII., p. 17, fig. 3.

1904. *Symphodus szajnochæ* C. R. Eastman, Bull. Mus. Comp. Zool. Vol. XLVI., no. 1, p. 29, Pl. I., fig. 5.

1904. *Crenilabrus szajnochæ* D. S. Jordan, Science, n.s., Vol. XX., p. 245.

A species attaining a total length of about 12 cm. to the base of the caudal fin. Snout not produced and but little pointed; trunk oblong and laterally compressed. Vertebræ about twenty-eight in number, of which sixteen are caudal. Dorsal fin much extended, with thirteen spines and eighteen soft rays; anal fin with three stout spines and eight articulated rays; caudal fin rounded, with sixteen principal rays preceded by several shorter ones above and below, which are supported by the epi- and hypaxial processes of the three hindermost vertebræ. Scales of moderate size, finely striated, but not posteriorly serrated. Operculum and pre-operculum with denticulated posterior margin. Marginal teeth conical, slightly recurved; pharyngeal dentition not observed.

Type.—Imperfect fish; present location unknown.

Besides the type, which is small and imperfectly preserved, but one other example of this species has hitherto been made known. This second specimen is now the property of the Museum of Comparative Zoölogy at Cambridge, Mass., and, like the holotype, is of small size, having a total length of 10 cm. to the base of the caudal fin. In point of preservation it leaves much to be desired, and although associated with the genus *Symphodus* by the present writer, in the opinion of Dr.

D. S. Jordan it seemed preferable to regard it and also the holotype of "*Crenilabrus*" *szajnochæ* as pertaining to a distinct genus. This suggestion of Dr. Jordan is now adopted, and the two previously described specimens together with two additional examples belonging to the Carnegie Museum and figured in the present paper, are placed in a new genus, *Eolabroides*, of which the diagnosis has just been given, and the specific characters of the type-species redefined.

Both specimens belonging to the Carnegie Museum are preserved in counterpart. The larger of them is cataloged under separate numbers, one for each half (4340 and 5303). The two halves of the smaller specimen are cataloged as 4331 and 4331*a* respectively. One of the counterparts of each specimen is figured in the accompanying plates, and that bearing the catalog number 5303 has been submitted to Dr. Gill for examination, he having expressed a desire to study its characters, and in particular to compare the skeleton with Agassiz's figure of a unique fish from Monte Bolca, named by him *Toxotes antiquus*.

Concerning the type of the last-named form, Dr. Gill is convinced that it has nothing in common with the modern freshwater group of Toxotids or archer-fishes,[10] all referable to a single genus, but on the whole is unwilling to speak confidently as to its precise systematic position, like Agassiz himself, who was perplexed to locate the example of the so-called "*Toxotes antiquus*" which came under his observation.

Under date of May 28, 1913, Dr. Gill has been kind enough to state for the writer's benefit his conclusions on these matters in the following paragraph of a personal letter: "The specimen figured by Agassiz does not belong to the genus *Toxotes*, as is evident from the general form, the development of the fins, and the abdominal cavity. The specimen you have sent me is not congeneric with Agassiz's and is, so far as the evidence goes, a Labrid. I cannot identify it with any recent form, however. If my count is correct, it has the fin-formula:

D. XIV+14; A. III+6; C. 5+13 (branched)+4.

I will count the rays again. Give my kind regards to Dr. Holland, and explain why I did not acknowledge receipt of the specimen before."

In a subsequent letter, dated August 21, 1913, the same eminent authority makes the following additional statement:

"The so-called *Toxotes antiquus* of Agassiz is entirely distinct generically from the modern genus *Toxotes*, and I doubt whether it belongs to the same family. The two differ in these respects:—

[10] Gill, Theodore N., "The Archer-fish and its Feats." Smithson. Misc. Coll., Vol. LII, 1909, No. 1861, pp. 271–286.

Toxotes (living).	*' Toxotes ' antiquus* Ag.
Body rhomboid.	Body compressed, fusiform.
Back declivous from dorsal to snout.	Back convex from dorsal to snout.
Dorsal with 4 to 6 graduated stout spines followed by shorter branched rays.	Dorsal with several weak spines followed by longer branched rays.
Anal longer than dorsal, with 3 stout spines.	Anal much shorter than dorsal.

"The distinctive characters are not patent in the fossil nor in the figure of *' Toxotes,'* so that I cannot give the systematic position of either the fossil you have sent me, or of the so-called *' Toxotes ' antiquus*. Like so large a proportion of other fossil fishes uncertainty must remain for the present." (*Cf.* Appendix, p. 345).

Family Pomacentridæ.

This is a family of marine fishes, with skeleton closely similar to that of the Chromidæ and Labridæ. The narial opening is single on each side, and the scales are usually ctenoid.

Genus Odonteus Agassiz.

13. **Odonteus sparoides** Agassiz.

(Plate XLVII, fig. 1)

1839. *Odonteus sparoides* L. Agassiz, Poiss. Foss., Vol. IV, p. 178, Pl. XXXIX, fig. 2.

1898. *Odonteus sparoides* var. *depressus* F. Bassani, Palæont. Ital., Vol. III, p. 83, Pl. VIII, fig. 2.

1911. *Odonteus sparoides* C. R. Eastman, Mem. Carnegie Museum, Vol. IV, No. 7, p. 379, Pl. XCVII, fig. 1.

Type.—Imperfect fish; Paris Museum of Natural History.

This is an extremely rare form, only a few specimens of which are to be found in European Museums, and two in the Carnegie Museum. One of these has already been figured in volume IV of the Memoirs, and the second example is shown of the natural size in Plate XLVII, Fig. 1. It bears the catalog number 5307, and is probably an immature individual.

Family Percidæ.

Teeth small and conical, usually extending over inner bones of the mouth; pre-operculum serrated. Lower pharyngeal bones nearly always separate. Spinous portion of dorsal fin usually as much extended as the articulated portion; anal fin usually with one to three, rarely five to seven spines, nearly equal, and opposite

to the hinder dorsal fin. The family comprises marine and freshwater fishes universally distributed in temperate and tropical regions.

Genus Cyclopoma Agassiz.

This genus, supposedly extinct, includes a few Tertiary species, which structurally bear a considerable resemblance to the existing *Lates*, and are actually referred to that genus by P. Bleeker (Archiv. Néerland, 1876, Vol. XI, p. 263). We prefer to follow the example of A. Smith Woodward, however, who agrees with the original author in regarding it as a distinct genus.

14. **Cyclopoma** (?) **micracanthum** (Agassiz).

(Plate XLV, fig. 3, and Plate XLVII, fig. 2).

1796. *Holocentrus maculatus* G. S. Volta, Ittiolit. Veronese, p. 234, Pl. LVI, fig. 3 (*errore*).

1796. *Amia indica* G. S. Volta, ibid., p. 149, Pl. XXXV, fig. 4 (*errore*).

1818. *Amia indica* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 347.

1835. *Smerdis micracanthus* L. Agassiz, Poiss. Foss., Vol. IV, p. 33, Pl. VIII, figs. 1, 2.

1836. *Dules medius* L. Agassiz, *ibid.*, p. 93, Pl. XIII, fig. 4.

1901. *Cyclopoma (?) micracanthum* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. IV, p. 504.

1905. *Cyclopoma (?) micracanthum* C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p. 25.

1911. *Cyclopoma (?) micracanthum* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 375.

Type.—Imperfect fish; *olim* Hartman collection, Göppingen.

This is a very small species, attaining a total length of about 10 cm. Length of head with opercular apparatus about equal to the maximum depth of the trunk and slightly exceeding one-third of the total length to the base of the caudal fin. Anterior dorsal fin with one spine and eight or nine articulated rays, its anterior origin as far from the occiput as the termination from the caudal fin; the second to fourth spines about equal in size, their length not exceeding one-half the depth of the trunk at their insertion, and scarcely exceeding that of some of the divided rays. Anal fin with three spines and six articulated rays, less than the posterior dorsal in extent; the second anal spine stoutest, but not longer than the third.

Two small but excellently preserved examples of this species are contained

among the specimens belonging to the Bayet Collection, and are shown in the accompanying plates (Cat. Nos. 5320 and 5329). Most of the structural details are displayed in the larger of these to better advantage than in any other specimen which has come under the observation of the writer.

Genus Dules.

This recent genus is represented in the Upper Eocene fish-fauna of Monte Bolca by a single species, *D. temnopterus* Agassiz, of which but few examples are known. None are preserved in the British Museum; only one (the original holotype) in the Paris Museum, and but three in the Carnegie Museum. These last-mentioned examples are cataloged as Nos. 4297, 5316+6315*a* and 5324. They are all smaller than the holotype and are evidently immature, but well preserved. Agassiz's description of this species is to be found in volume IV, p. 91, of his Recherches sur les Poissons Fossiles, 1836.

Suborder Scombroidei.

Maxillaries more or less firmly attached to the non-protractile premaxillaries, which are typically produced and pointed anteriorly. Cranium with the orbito-rostral portion elongate and the postorbital portion abbreviate; parietals separated by the supra-occipital; no orbitosphenoid; basisphenoid present; pro-otics giving rise to an osseous roof for the myodome. Vertebral column of solid centra which are co-ossified with the arches. Pectoral arch attached to the cranium by a forked post-temporal; no mesocoracoid; pterygials more or less regularly hourglass-shaped, four in number, three of them attached to the scapula. Pelvic fins of a spine and five soft rays or variously reduced, thoracic or subthoracic in position, the pelvic bones attached to the clavicles.

Division Xiphiiformes.

Hypural nearly or quite hidden by the bases of the caudal fin-rays. A long pointed rostrum, formed by the united premaxillaries and by the nasals, the latter meeting in front of the ethmoid and then diverging and tapering forward. Mouth with lateral cleft; teeth small or absent. Epi-otics separated by the supra-occipital. Pectoral fins placed low.

Family Blochiidæ.

Vertebral column consisting of twenty-four vertebræ. Pelvic fins absent. Neural and hæmal spines not expanded. Ribs apparently sessile. Body covered with slightly imbricated, diamond-shaped, bony scutes; two longitudinal series of enlarged scutes on each side.

The above re-descriptions of the larger groups of Scombroid fishes are taken from Dr. Regan's diagnoses as contained in his paper published in the Annals and Magazine of Natural History for January, 1909. It is of interest to note that in this paper the genus *Blochius* is removed from association with Blennoid fishes, and assigned to a position intermediate between sail-fishes (*Histiophorus* and *Tetrapterus*) and sword-fishes (Xiphiidæ).

Blochius, an extinct genus and the solitary representative of the family to which it belongs, has been regarded by paleichthyologists from Agassiz onward as of doubtful systematic position. Certain cylindrical spines, found always in the detached condition, and assigned to the provisional "genus" *Cœlorhynchus*, have been compared with the slender, elongate rostrum of *Blochius*, and a theoretical association of these remains is perhaps permissible. But it is a matter of considerable interest to note the resemblances to which Regan has called attention between *Blochius* and *Xiphias*.

For instance, in the paper above referred to, Dr. Regan speaks as follows:

"The adult *Xiphias gladius* differs considerably from *Blochius*, but very young specimens clearly show its relationship to the extinct genus. An example of nearly 200 mm. in the British Museum is very similar to *Blochius longirostris*, resembling it in the long slender jaws, the elongate body with the greatest depth just behind the head, and the continuous dorsal fin. The body is covered with rough non-imbricated scales, with four longitudinal series of enlarged scales on each side, two corresponding in position to the lateral series in *Blochius* and the others running at the base of the dorsal and anal fins."

Concerning the osteology of Scombroid fishes in general, reference may be made at this point to the important papers of E. C. Starks on this subject published in the Journal of Morphology, Vol. XXI, pp. 77–79, and in the Leland Stanford Junior University Publications, University Series, No. 5, 1911.

Suborder Gobioides.

Pelvic fins thoracic; opisthotic enlarged, extending downwards to the basioccipital.

Family Gobiidæ.

This family comprises small fishes, which are widely distributed on the coasts of temperate and tropical seas, sometimes also occurring in fresh water. With the exception of the single genus *Eocottus*, the precise systematic position of which is doubtful, no satisfactorily preserved remains of this family have been discovered. In the opinion of Dr. A. Smith Woodward *Eocottus* should be placed in the family Cottidæ among the Scorpæniformes. More recently Dr. Regan has expressed the

opinion that "the Eocene *Eocottus* may be a Gobioid, and *Lepidocottus* also may belong to the same group."[11]

Genus Eocottus A. S. Woodward.

15. **Eocottus veronensis** (Volta).

1796. *Gobius barbatus* G. S. Volta, Ittiolit. Veronese, p. 48, Pl. XI, fig. 1.
1796. *Gobius veronensis* G. S. Volta, *ibid.*, p. 51, Pl. XI, fig. 2.
1818. *Gobius veronensis* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 358.
1835. *Gobius macrourus* L. Agassiz, Neues Jahrb., p. 291 (name only).
1838–39. *Gobius macrurus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 12, 203, Pl. XXXIV, figs. 3, 4.
1876. *Gobius macrurus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 180.
1901. *Eocottus veronensis* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. IV, p. 581.
1911. *Eocottus veronensis* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 385, Pl. XCIX, fig. 1 (figure inverted).

Type.—Imperfect fish; Paris Museum of Natural History.

The best preserved examples of this species, which have thus far been brought to light, are those contained in the British and Carnegie Museums. Three specimens are listed in the published catalog of the latter institution, and we have now to record the accession of three additional specimens, smaller than the others, but fairly well preserved. These have received the catalog numbers: 5325, 5326, 5327.

Suborder Blennoidei.

Pelvic fins jugular or mental, each of one to four rays, the first of which may be spinous; parasphenoid sending up a wing on each side, which is joined by suture to the frontals.

Family Blennidæ.

Elongated fishes with stout caudal pedicle; snout not produced. Most of the abdominal vertebræ with downwardly directed transverse processes bearing the small ribs. Dorsal fin occupying nearly the whole of the back, often subdivided; anal fin also much extended; caudal fin rounded or tapering. Scales small or absent, and no bony scutes.

[11] Regan, C. T. "The Osteology and Classification of the Teleostean Fishes of the Order Scleroparei." Ann. & Mag. Nat. Hist., (8), Vol. XI, 1913, p. 181.

Genus Pterygocephalus Agassiz.

Head short and orbit very large; mouth small, with conical teeth. Vertebræ about ten in the abdominal, fourteen in the caudal region. Dorsal fin very high, the foremost large spine displaced forwards above the head, but the fin otherwise continuous, each scale with a longitudinal keel, and the keels forming regular lines along the trunk.

16. **Pterygocephalus paradoxus** Agassiz.

(Pl. XLV, Fig 5).

1796. *Labrus malapterus* G. S. Volta, Ittiolit. Veronese, p. 228, Pl. LV, fig. 3 (*errore*).

1818. *Labrus malapterus* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 351.

1835. *Pterygocephalus paradoxus* L. Agassiz, Neues Jahrb., p. 295 (name only).

1839. *Pterygocephalus paradoxus* L. Agassiz, Poiss. Foss., Vol. IV, p. 191, Pl. XXXII, figs. 5, 6.

1853. *Cristiceps paradoxus* J. Müller, Neues Jahrb., p. 123.

1876. *Cristiceps paradoxus* F. Bassani, Atti Soc. Veneto-Trent. Sci. Nat., Vol. III, p. 178.

1901. *Pterygocephalus paradoxus* A. S. Woodward, Cat. Foss. Fishes, Pt. IV, p. 595.

1905. *Pterygocephalus paradoxus* C. R. Eastman, Mém. Soc. Géol. France, No. 34, p. 29.

1911. *Pterygocephalus paradoxus* C. R. Eastman, Mem. Car. Mus., Vol. IV, No. 7, p. 388, Pl. XCVI, fig. 5.

Type.—Imperfect fish; Paris Museum of Natural History.

This, the type-species, includes small-sized fishes allied to the existing *Cristiceps*, the total length not much exceeding 5 cm. Length of head with opercular apparatus equalling maximum depth of trunk and somewhat less than one-third of the total length of the fish to the base of the caudal fin. Separate dorsal fin-spine about twice as long as the next, the length of which slightly exceeds depth of trunk at its point of insertion; continuous dorsal fin with nine spines and nine articulated rays; anal fin with three spines and seven articulated rays.

Two examples of this rare and interesting form are preserved in the Bayet Collection of the Carnegie Museum; one, cataloged as No. 4215, which has already been figured, and another which is larger and more perfect, cataloged under the numbers 5309+5309*a*. In this latter, which is in counterpart, all of the fins, the details of the squamation, and arrangement of cranial plates are very favorably displayed.

17. Gobius microcephalus Agassiz.

(Plate XLV, Fig. 6).

1839. *Gobius microcephalus* L. Agassiz, Poiss. Foss., Vol. IV, p. 204, Pl. XXXIV, fig. 2.

1901. *Gobius microcephalus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. IV, p. 588.

1905. *Gobius microcephalus* C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, p. 33; pl. II, fig. 3.

Type.—Imperfect fish; British Museum of Natural History.

The type and hitherto only known example of the species which has been called by this name is a small fish doubtfully assigned to a position among the Gobies by Agassiz, and considered by Woodward as "probably a Blennoid though not satisfactorily determinable."

The original author remarks that, without undertaking to fix definitely its precise systematic position, it is yet possible to point out its leading specific characters, and among these he notes the following: "d'une part, la position très avancée de l'anale, et de l'autre, la forme très raccourcie de la tête; caractère qui lui a valu de ma part le nom de *G. microcephalus*. La colonne vertébrale est loin d'être massive; les côtes sont longues et grèles. . . . La dorsale épineuse parait avoir été separée de la dorsale molle par une échancrure assez profonde; ses rayons vont en décroissant depuis le premier jusqu'au septième ou dernier, qui n'a pas même la moitié de la longuer des premiers rayons mous. Ceux-ci sont au nombre de neuf, au moins, et vont aussi en se raccourcissant d'avant en arrière. . . . L'anale est composée d'au moins six rayons, qui sont assez allongés. La caudale est très ample, en égard à la taille du poisson" (*l. c.*, p. 204).

Of this species but few examples are known. The British Museum possesses only the holotype, which is a small individual, and its precise systematic position is regarded as doubtful. None are to be found in the Paris Museum of Natural History, and none in this country, with the exception of two specimens belonging to the Carnegie Museum. One of these, cataloged as No. 5504, has already been figured in Vol. IV of the Memoirs of the Museum, and the other, which is larger and more perfect, has recently come to light. It bears the Catalog No. 5319.

APPENDIX.

[Since the foregoing pages were written and after they had been put into type, the Editor received a request from the Author to incorporate in the body of the text a lengthy series of changes and additions. A careful examination of this

new manuscript has satisfied the Editor that the proposed alterations do not justify the expenditure of time and money which would be called for in practically resetting the entire article. In deference, however, to the wishes of Mr. Eastman the Editor incorporates the essence of certain of his pages which seem worthy of being printed.

After relating the result of several private interviews with Dr. Theodore N. Gill, the Author announces that the so-called "*Toxotes antiquus*" (cf. pp. 337–8) should definitely be regarded as belonging to the fossil Labroids, and suggests the erection of a new genus for its reception, for which, in honor of Dr. Gill, he proposes the generic name *Gillidia*. The Editor takes pleasure in printing the diagnosis supplied by Dr. Eastman. *W. J. Holland.*]

GILLIDIA, gen. nov.

An extinct genus allied to *Eolabroides*, known at present only by the type species, which was described by Agassiz under the name of *Toxotes antiquus*. Head relatively long and low. Body of moderate size, compressed, fusiform, the dorsal contour from the snout to the middle of the back scarcely arched. Dorsal fin with six spinous rays, of which the first is short, and none are longer or stouter than the succeeding twelve articulated rays. Anal fin much shorter than the dorsal, with three stout spines followed by twelve branched rays. Caudal fin expanded, scarcely cleft, the superior lobe with eight, and inferior with seven, articulated rays. Squamation coarse, especially in the flank-region; scales with posterior margin entire.

18. **Gillidia antiquus** (Agassiz).

1796. *Sciæna jaculatrix* G. S. Volta, Ittiolit. Veronese, p. 183, pl. XLV, fig. 1 (*errore*).

1818. *Lutjanus ephippium* H. D. de Blainville, Nouv. Dict. d'Hist. Nat., vol. XXVII, p. 347 (*errore*).

1835. *Toxotes antiquus* L. Agassiz, Neues Jahrb., p. 302 (name only).

1835–42. *Toxotes antiquus* L. Agassiz, Poiss. Foss., Vol. IV, pp. 16*, 264, pl. XLIII.

1901. *Toxotes antiquus* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Vol. IV, p. 561 (*sub* Chætodontidæ).

1905. *Toxotes antiquus* C. R. Eastman, Mém. Soc. Géol. France, Vol. XIII, No. 34, p 25.

Holotype.—Imperfect fish preserved in counterpart; Paris Museum of Natural History (Cat. No. 10,812 + 10,813).

The only known example of this species is that which has already served for the original of figures and descriptions by Volta and Agassiz. It would be superfluous to here enumerate the specific characters, which have been noted in considerable detail by the latter author.

Genus Mene Lacépède.

[In Part I of the "Catalog of Fossil Fishes in the Carnegie Museum," Memoirs Carnegie Museum, Vol. IV, p. 366, Mr. Eastman alluded to the fact that numerous fine examples of *Mene rhombea* (Volta) are contained in the collection, but gave no figure of the species, except a reproduction of a text-figure, showing the cranial osteology, taken from Cramer's article entitled "Ueber *Mene rhombeus* (Volta)" (*cf.* Zeitschr. deutsch. geol. Gesell., Vol. LVIII, 1906, pp. 181–212). This omission the Editor supplies in Plate XLVIIA by a figure of one of the well-preserved specimens belonging to the Bayet Collection (No. 4369), showing the remarkable development of the anterior rays of the pelvic fins. The introduction of this plate is made in order to visualize the difference between *Mene rhombea* (Volta), *Mene oblonga* (Agassiz) (*cf.* Eastman, Memoirs Carnegie Museum, Vol. IV, Pl. XCII, fig. 3), and the species hereinafter described by Eastman as a new species under the name *Mene novæ-hispaniæ*, *cf.* Text-figure 4. *W. J. Holland.*]

19. Mene novæ-hispaniæ, sp. nov.

1755. "Fish which we call an old-wife." F. Byam, Philos. Trans., Vol. IX, p. 295, Pl. IX.

Type.—Figure of a fish found in counterpart on the island of Antigua, the location of the specimen not now being known.

Closely resembling *M. rhombea*, but the dorsal border less strongly arched, and trunk not so deep as in that species. Maximum depth of trunk equalling its length from the pectoral arch to the base of the caudal fin, and the latter apparently slightly excavated. Dorsal fin located as in *M. rhombea;* but giving no evidence as to the extent of elongation of the anterior ray of the pelvic fin.

* * * * * * * * * * * * * * * * * *

From the standpoint of paleogeographical distribution, and also as a criterion for determining the age of the strata exposed at an elevation of about 900 feet above sea-level in the Island of Antigua, it is a matter of considerable scientific interest to be able to determine positively the presence of a species of *Mene*, hitherto unrecognized as such, and indeed unnamed, in the older Tertiary rocks of the western hemisphere. Historical interest also attaches to the fact that the original

specimen to which attention is now directed formed the subject of the earliest published contribution to the literature of paleichthyology emanating from the New World.

The communication referred to is in the form of a letter written by the Rev. Francis Byam under date of March 31, 1755, and read before the Royal Society of London in December of that year. It is printed in Volume XLIX (page 295) of

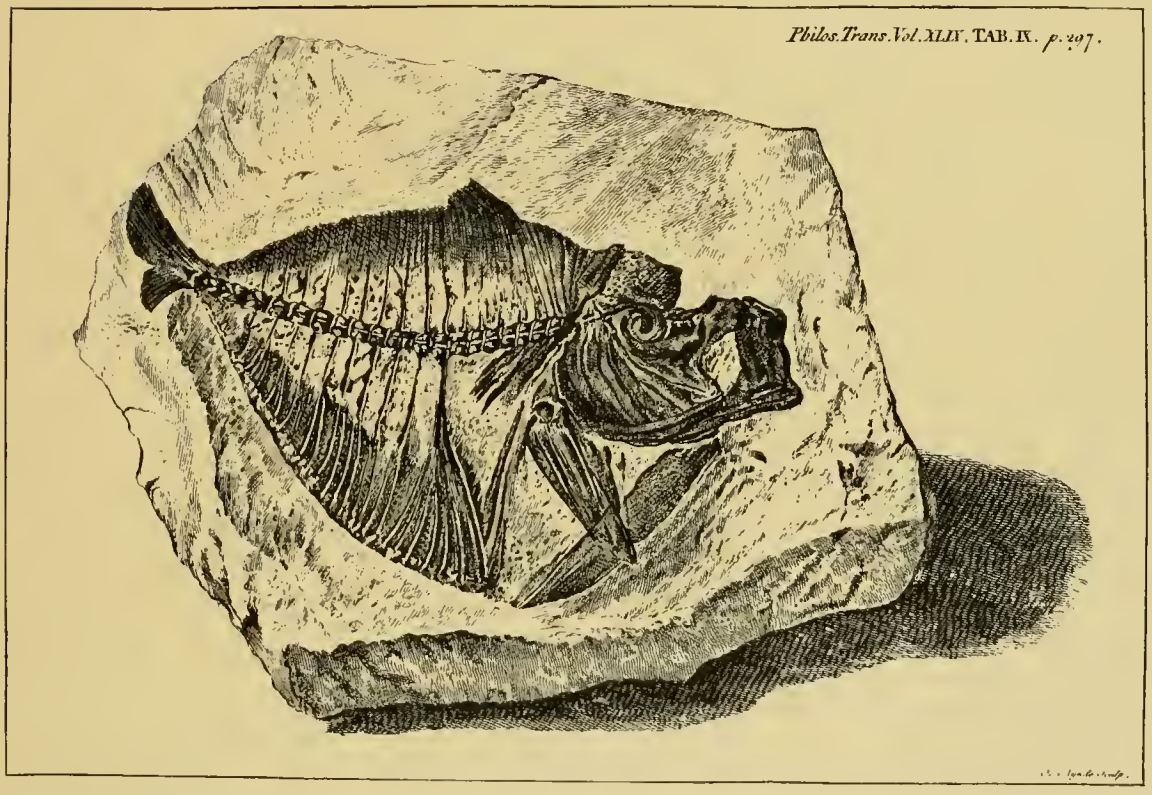


FIG. 4. *Mene novæ-hispaniæ* Eastman. (Type.) Being a reproduction of about one-half size of the illustration given in the Philosophical Transactions, Vol. XLIX, Plate IX, 1755. (Photographed by A. S. Coggeshall).

the Philosophical Transactions of that body, accompanied by a steel engraving which portrays the original specimen. This engraving is reproduced in fig. 4, which is a little more than one-half the size of the original. As both the illustration and the published account of the fossil fish have been overlooked by modern ichthyologists, it may be of service to quote the following passage:

'To William Fauquier, Esq., F.R.S.

. . . As you have the honour to be a member of the Royal Society, I have sent you, by Captain Barrett, in a box directed for you, what I esteem to be a great curiosity. It is a stone, that was brought from a quarry, for a building in the

town: the quarry is in the side of a mountain, and is about three hundred yards higher than high-water mark, and about two miles from the sea. When the mason struck it with his hammer, it split in two, and discovered the exact portraiture of a fish (on each stone) which we call an old wife.'

* * * * * * * * * * * * * * * * * *

That which is chiefly interesting to note in regard to this specimen, which clearly belongs to a new species, is that its position in the line of evolutionary progression is intermediate between the two other known fossil forms, *M. rhombea* and *M. oblonga*. The fact that these two are both from an upper Eocene horizon furnishes additional evidence in support of the view of Dr. T. Wayland Vaughan and others that the fossiliferous strata of Antigua are of early Tertiary age. Indeed, all the data that are now available favor a correlation of these beds with the Upper Eocene.

* * * * * * * * * * * * * * * * * *

Mr. Eastman also calls attention in his manuscript to the fact that two other species of fossil fishes from the West Indies have been discovered, both of which appear to have eluded the notice of some recent writers and catalogers. They are:

Aëtobatis poeyi Castro, Anales Soc. Españ. Hist. Nat., Vol. III, 1873, p. 193, from the Tertiary of Cuba; and

Zebrasoma deani Hussakof, Bull. Amer. Mus. Nat. Hist., Vol. XXIII, 1907, pp. 125–6.

The latter is "the first fossil species known to be referable to the genus *Zebrasoma* Swainson," *cf.* Hussakof. *l.c.*

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Trygon muricata (VOLTA). $\times \frac{1}{3}$ *circa*. C. M. CAT. FISHES, No. 4304.

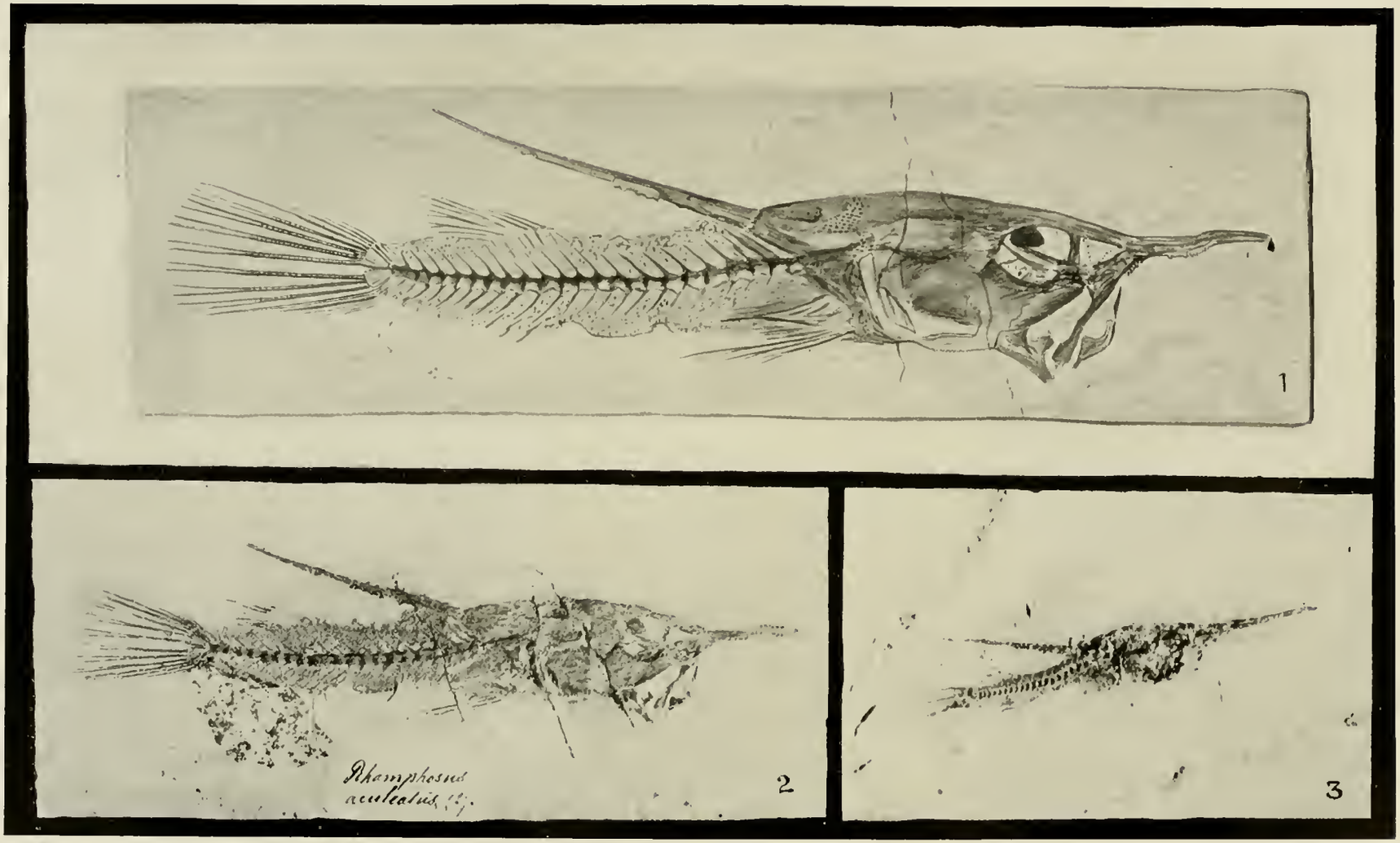

FIG. 1. *Rhamphosus rastrum* (VOLTA). $\times \frac{3}{2}$. C. M. CAT. FOSS. FISHES, No. 5328.
FIG. 2. *Rhamphosus rastrum*. NAT. SIZE. C. M. CAT. FOSS. FISHES, No. 5328.
FIG. 3. *Rhamphosus rastrum* JUV. NAT. SIZE. C. M. CAT. FOSS. FISHES No. 5310.

FIGS. 1–2. *Eobothus minimus* AGASSIZ. NAT. SIZE. C. M. CAT. FOSS. FISHES, NOS. 5314a, 5314.
FIG. 3. *Cyclopoma micracanthum* AGASSIZ. $\times \frac{3}{2}$. C. M. CAT. FOSS. FISHES, NO. 5329.
FIG. 4. *Amphistium bozzianum* MASSOLONGO. $\times \frac{1}{2}$. C. M. CAT. FOSS. FISHES, NO. 5308.
FIG. 5. *Pterygocephalus paradoxus* AGASSIZ. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 5309a.
FIG. 6. *Gobius microcephalus* AGASSIZ. $\times \frac{3}{2}$. C. M. CAT. FOSS. FISHES, NO. 5319.

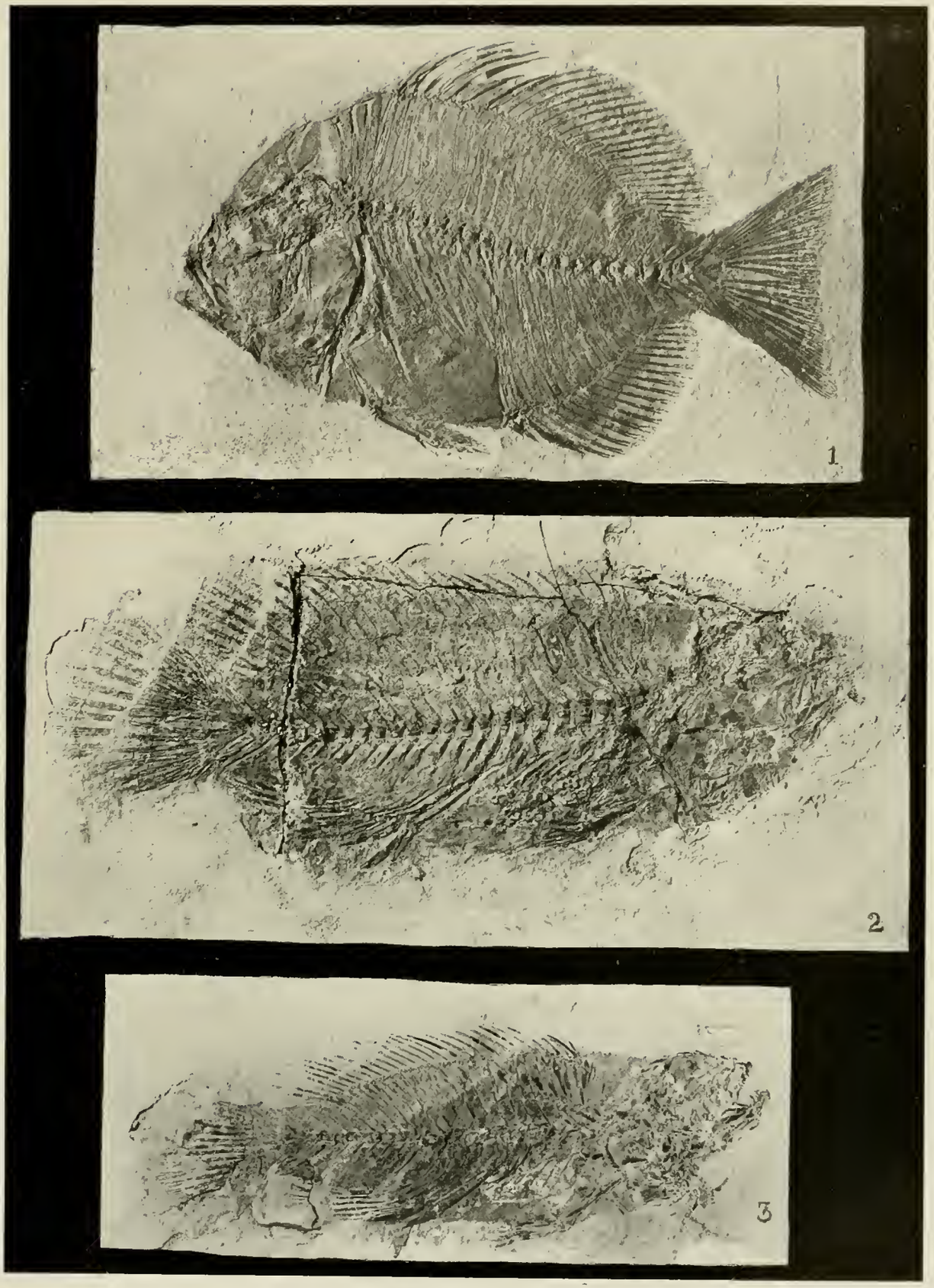

FIG. 1. *Ephippus rhombus* BLAINVILLE. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 5305.
FIG. 2. *Eolabroides szajnochæ* ZIGNO. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 5303.
FIG. 3. *Eolabroides szajnochæ* ZIGNO. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 4331a.

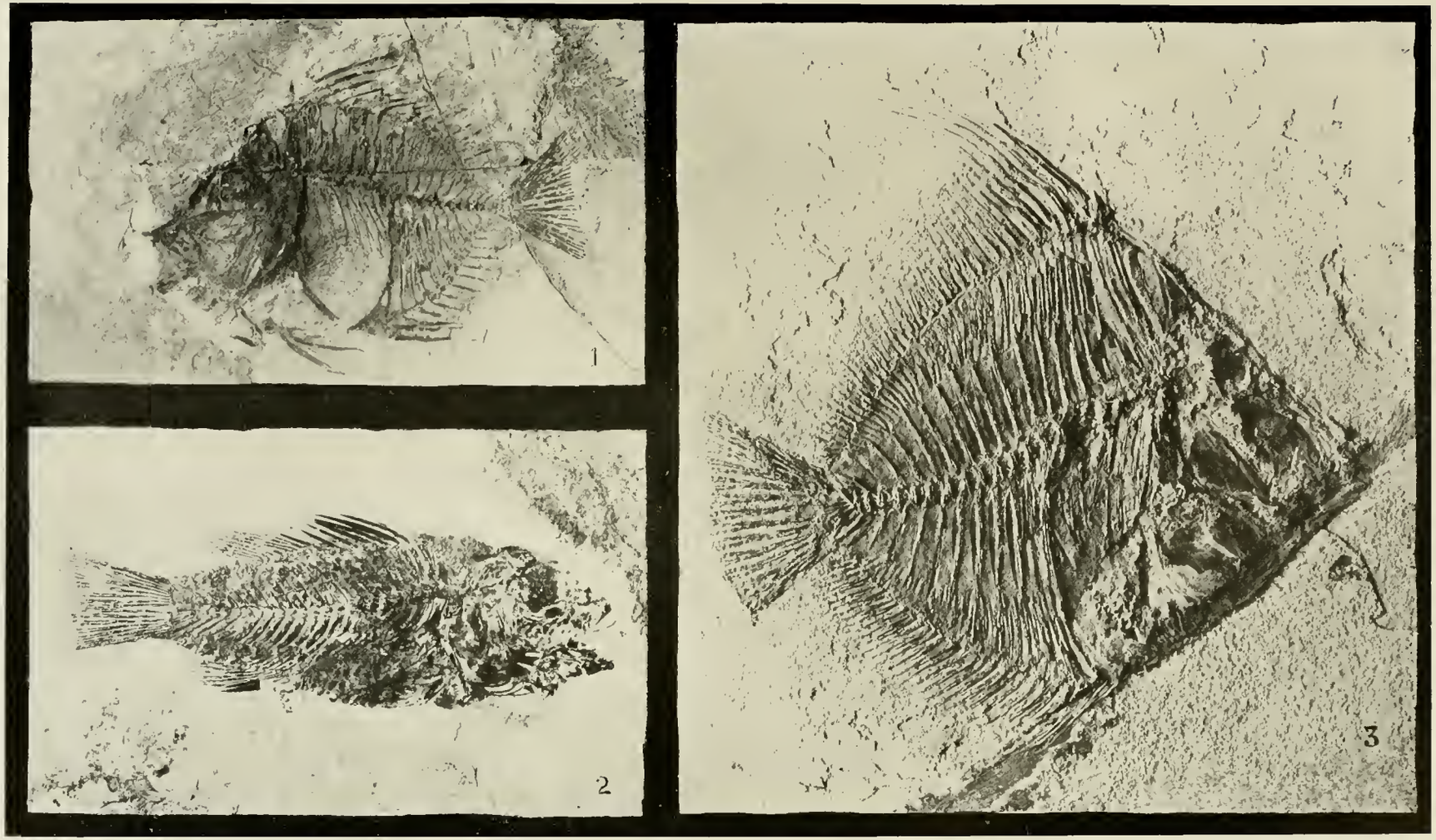

FIG. 1. *Odonteus sparoides* AGASSIZ. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 5307.
FIG. 2. *Cyclopoma micracanthum* AGASSIZ. $\times \frac{3}{4}$. C. M. CAT. FOSS. FISHES, NO. 5320.
FIG. 3. *Zanclus brevirostris* AGASSIZ. NAT. SIZE. C. M. CAT. FOSS. FISHES, NO. 5306.

Mene rhombea (VOLTA.) C. M. CAT. FOSS. FISHES, NO. 4369. (SLIGHTLY REDUCED.)

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PART III. CATALOG OF FOSSIL FISHES FROM THE LITHOGRAPHIC STONE OF CERIN, FRANCE

By C. R. EASTMAN

PITTSBURGH.

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VOL. VI. NO. 6.

CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM. PART III. CATALOG OF FOSSIL FISHES FROM THE LITHOGRAPHIC STONE OF CERIN, FRANCE.

By C. R. Eastman.

(Plates XLVIII–LVI.)

The subject matter of the following Catalog consists of a large and representative assortment of Upper Jurassic fishes from Cerin (Ain) in southeastern France, the material being contained in the Bayet Collection, which was acquired by the Museum through the generosity of Mr. Andrew Carnegie in 1903.

It is now generally considered that the deposits of lithographic limestone in the Department of Ain, France, and in the vicinity of Solenhofen, Bavaria, are of contemporary age, both being referable to the Lower Kimmeridgian division of the marine Upper Jura, and not to the Corallian (upper member of the Middle Jura), as some writers have supposed. The stratigraphic relations of the fish-bearing beds at Cerin will be clear from an inspection of the annexed diagram showing the geological section across this region.

Essentially the same ichthyic fauna is represented in the lithographic stone of Cerin, France, and in similar deposits of the general region around Solenhofen, Bavaria; the latter locality, however, furnishing the more abundant and more diversified forms of animal life. The composition of the fish-fauna is essentially " ganoid "; that is to say, teleost fishes of the Crossopterygian and Actinopterygian orders predominate, cartilaginous forms are in the minority, and the Dipnoan sub-class is without known representatives. Among Elasmobranch fishes the Batoidei, or rays, outnumber the sharks, and Holocephali occur very sparsely

at the Bavarian locality, no trace of them having been found in the corresponding deposits in France. In many cases where the same genera occur in both localities, they are found to be represented by different species, as is perhaps natural to expect from the point of view of geographic distribution.

Besides the fishes, some fifty species of which were known from Cerin during the life-times of Louis Agassiz and Victor Thiollière, mention should be made of

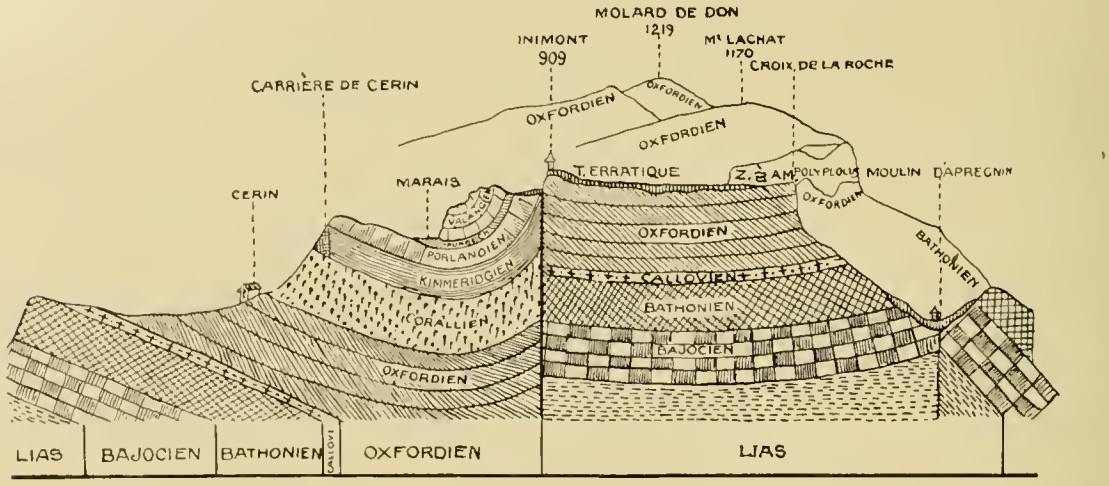


Fig. 1. Geological Section in the Vicinity of Cerin, France. (After Gervais).

the occurrence of Rhynchocephalian and Pterosaurian genera in the French deposits, also of a considerable number of insects and crustacea, apparently identical with those which are found in Bavaria.

Of somewhat different nature lithologically, but yielding approximately the same ichthyic fauna, and regarded in consequence as the homotaxial equivalent of the beds at Cerin, is the Lower Kimmeridgian bituminous limestone of Orbagnoux, Ain, France. One of the pioneer students of this fauna, Victor Thiollière of Lyons, writing in 1854, speaks as follows regarding the synchronism of the deposits at Orbagnoux, Cerin, and Solenhofen:

" Les schistes d'Orbagnoux sont principalement représentés dans la collection de M. Itier par leurs végétaux nombreux et variés; mais ils avaient aussi fourni . . . toute une serie de *Thrissops, Leptolepis, Aspidorhynchus, Caturus, Pycnodus* [=*Microdon*? Eastman] et autres poissons, que j'ai examinés avec d'autant plus d'intérêt qu'ils m'ont donné la pleine conviction de l'identité de la faune ichthyologique des schistes bitumineux avec celle des calcaires lithographiques. Cette identité, que je n'avais annoncée en 1850 que sur des preuves moins décisives, ne peut pas plus être revoquée en doute aujourd'hui, que celles de tout l'ensemble qui

en resulte avec la faune de Solenhofen." "Les Poissons Foss. &c., dans le Bugey," p. 3.

The medium in which organic remains are preserved in the calcareous and bituminous deposits of southeastern France has not the same fineness as that of the Bavarian lithographic stone, hence the more delicate details are less exquisitely portrayed in the form of impressions than at the famous locality of Solenhofen. Nevertheless the perfection in which most of the hard parts are preserved in the rock is truly marvellous. The chief difficulty with which vertebrate paleontologists have to contend is the accidental distortion or displacement of parts owing to pressure of freshly deposited sediment during fossilization.

A brief résumé may be offered at this point concerning earlier contributions to our knowledge of the Jurassic fish-fauna of the Bugey. Local geologists appear to have become interested in collecting fossil remains from this region as early as the second decade of the nineteenth century, and credit for having discovered the fish-bearing beds of Cerin is awarded by later writers to M. Jules Itier, who began in 1821 the preparation of a geological map of the Department of Ain. The conclusions reached by this excellent observer after many years of patient effort were finally published in a communication entitled " Memoirs sur les roches asphaltiques de la chaîne du Jura."[1]

In 1838 a civil engineer and geologist, named M. Drian, brought together a small collection of fish-remains from the quarries of lithographic stone of Cerin in the commune of Marchamp (Ain), and some eight years later these remains passed into the hands of M. Victor Thiollière of the University at Grenoble, who at once became deeply interested in their investigation, and whose labors were unfortunately cut short by death before his final memoir was completed. It is affirmed by Professor Thiollière's associates, MM. Falsan and Dumortier, that the beginning of our knowledge of the Cerin fish-fauna is traceable to the lively curiosity aroused by the collection of the Lyonese geologist, Drian. The latter, in 1838 as stated by these authors, " découvrit les belles empreintes de poissons de la carrière de Cerin, commune de Marchamp (Ain); puis en 1846 il les communiqua à V. Thiollière. L'examen de ces échantillons fut le point de départ des persévérantes et remarquables recherches de ce dernier savant, qui, pour s'occuper uniquement de l'étude de cette riche faune et pour combler une lacune restée dans les travaux géologiques français n' hésita pas à abandonner le tracé de la carte géologique du département du Rhone."

Two short notices were published by M. Thiollière during the years 1848–50, the second of which contained a description of certain reptilian remains from the

[1] Bull. de la Soc. de Statistique de l'Isère, Vol. II, 1839, p. 128.

same region, which had been submitted to Hermann von Meyer and studied by him.[2] In 1854 appeared the handsome memoir of Thiollière, upon which his claims for recognition as a student of paleichthyology chiefly rest.[3] The sequel to this work was not completed during the author's life-time, although a dozen plates intended for its illustration had been printed in 1858, and were exhibited before the visiting members of the French Geological Society at a meeting held at Nevers in that year. A short paper presented by Thiollière on this occasion was his last published contribution,[4] death having ensued a few months later; but in 1873 the aforementioned plates were issued under the editorial care of M. Paul Gervais, accompanied by annotated extracts from some of Thiollière's earlier writings, and by essays on the local paleobotany and a stratigraphic section at the hands of Count de Saporta and MM. Falsan and Dumortier. This publication, designated as "seconde livraison," appears under the same title as Thiollière's memoir of 1854, and is evidently intended to be supplementary to it.

At the beginning of his introductory remarks prefixed to the memoir of 1873 just referred to, Professor Gervais makes the following significant observation: "Une étude plus complète de la collection Thiollière, aujourd'hui déposée au Muséum de Lyon, et une nouvelle comparaison des poissons qu'elle comprend avec ceux qu' on a recueillis dans les terrains analogues de la Bavière et ailleurs, conduiront à des résultats plus importants encore. Nous ne saurions trop recommander ces recherches aux naturalistes qui seront en mesure de les accomplir."

We have quoted the foregoing remarks in order to show that it was realized by competent paleontologists two score years ago that a thorough-going revision and comparative study of the Solenhofen and Cerin vertebrate faunas was a desideratum, and that such an investigation promised extremely valuable results. Thiollière and Andreas Wagner of Munich had previously held the same opinion, as will appear from the following comments of the first-named author, with reference to the collections from Solenhofen: "On sait que les richesses dont il s'agit n'ont pas été suffisamment étudieés par M. Agassiz. Il est urgent, comme le remarque

[2] Première notice sur un nouveau gisement de poissons fossiles dans le Jura du Département de l'Ain. Annales de la Soc. Nationale d'Agriculture, Histoire Naturelle, et Arts Utiles de Lyon, Vol. I, 1849, pp. 43–66.

Seconde notice sur le gisement et sur les corps organisés fossiles des calcaires lithographiques dans le Jura du Département de l'Ain, comprenant la description de deux reptiles inédits provenant de ces couches, par M. Hermann de Meyer. Lyons, 1850, p. 80, with 2 plates.

[3] "Description des Poissons Fossiles Provenant des Gisements Coralliens du Jura dans le Bugey." Lyons, 1854, pp. 28, with 10 plates.

[4] "Notice sur les Poissons Fossiles du Bugey et sur l'Application de la Méthode de Cuvier à leur Classement." Bull. Soc. Géol. de France, Vol. XV, p. 782.

fort justement M. Wagner, de faire disparaître les lacunes, les doutes, et les inexactitudes que le célèbre naturaliste de Neufchâtel a été forcé de laisser dans ses *Recherches*, relativement aux espèces des schistes lithographiques de la Bavière."[5]

Fortunately for the science of paleichthyology the lacunæ in our knowledge of the Kimmeridgian fish-fauna of Bavaria, of which writers of half a century ago complained, have been in large measure filled by the unremitting researches of a long procession of students. Deficiencies still exist, however, in the extent and thoroughness of our knowledge of the contemporary ichthyic fauna of southeastern France. The quarries of lithographic stone in this region are relatively little worked and in some localities have been abandoned; the supply of materials is at best scanty; and the region is less easily accessible than the level plateau country of the Alb in northern Bavaria.

For these and various other reasons comparatively few investigators have been in later years attracted to the study of the Cerin fauna. The list is, indeed, exhausted when we have mentioned the names of A. Wagner and Karl A. von Zittel of Munich, and Professor Albert Gaudry of Paris, all deceased, and H. E. Sauvage of Boulogne-sur-Mer, and Dr. A. Smith Woodward of London. Through exchange with the Lyons Museum of Natural History in 1873, a number of well-preserved specimens from Cerin were received by the Museum of Comparative Zoölogy at Cambridge, Massachusetts. This material has been studied in connection with that belonging to the Carnegie Institute in Pittsburgh, and a portion of the results is incorporated in the present modest contribution.

After the above general statements we proceed to the description of the different genera and species from Cerin represented in the collection of the Carnegie Museum. As in the preceding parts of the Catalog, the systematic arrangement of families and genera follows closely that laid down in Dr. A. Smith Woodward's "Catalogue of Fossil Fishes," and the chief diagnostic characters have been almost entirely extracted from the same source.

CLASS PISCES.

Subclass I. ELASMOBRANCHII.

Order PLAGIOSTOMI.

"Head prolonged in front of the ventrally-situated mouth as a more or less prominent pre-oral rostrum; vertebral column consisting of alternating basi- and inter-dorsal cartilages, generally supported by more or less well developed chorda-centra. Pectoral and pelvic fins uniserial. Pelvic girdle and claspers

[5] Memoir of 1854, p. 6.

present. Except in two families the branchial arches and clefts are invariably five in number. An operculum is not developed." (T. W. Bridge, Cambridge Natural History, Fishes, p. 442).

Suborder *BATOIDEI.*

"Body generally discoidal or rhombic in shape, the axial portion being formed by the flattened head and trunk, and the lateral portions by the enormously expanded pectoral fins, which are usually confluent with the sides of the head. Tail slender, sharply marked off from the trunk, to which it usually appears as a mere appendage. Dorsal fins, when present, on the tail. Anal fin absent. Branchial clefts ventral in position. Spiracles large, usually crescentic. Vertebræ tectospondylic." (T. W. Bridge, *l. c.*, pp. 457–8).

Family RHINOBATIDÆ.

"Tail strong and long, with two well-developed dorsal fins; a caudal and a longitudinal fold on each side. Disk not excessively dilated, the rayed portion of the pectoral fins not being continued to the snout. No electric organs in the living forms." (A. S. Woodward, Cat. Fishes B. M., Pt. I, p. 77). Teeth small, numerous, in pavement.

Genus Belemnobatis Thiollière.

"Tail very distinct from the disk, which is almost of rhombic shape. Pectoral fins not extending forwards beyond the base of the snout; pelvics not notched. Tail with two smooth spines upon the proximal half, and *apparently* two dorsal fins on the distal half, without caudal fin. Body partially covered with conical dermal tubercles, the larger only superficially calcified. Teeth minute, smooth." (A. S. Woodward, *l. c.*, p. 83).

1. **Belemnobatis sismondæ** Thiollière.

1854. *Belemnobatis sismondæ* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 8; pl. III, fig. 1.

1873. *Belemnobatis sismondæ* Thiollière.

Op. cit., Pt. II (*ed.* P. Gervais), p. 12; pl. I, fig. 1.

1889. *Belemnobatis sismondæ* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. I, p. 84.

Type.—Complete skeleton; present location unknown.

"Snout moderately obtuse; tail shorter than disk. Dermal tubercles largest between the pelvic fins; of considerable size along the median line of the back and on the anterior portion of the disk." (A. S. Woodward, *l. c.*, p. 84). Total length upwards of 50 cm.

This rare form, of which but few specimens have been brought to light, is represented in the collections of the Carnegie Museum from Cerin, by a single imperfect individual, which displays the greater part of the disk and a few caudal vertebræ. Both the pectoral and pelvic arches together with the branchial clefts and cartilaginous rays (radialia) of both pairs of fins are well exhibited. The specimen is cataloged as No. 5131.

Subclass TELEOSTOMI.

Order CROSSOPTERYGIA.

Suborder *ACTINISTIA*.

Family CŒLACANTHIDÆ.

"Body deeply and irregularly fusiform, with cycloidal, deeply overlapping scales, more or less ornamented with ganoine. Branchiostegal apparatus consisting of an operculum on each side and a single pair of large jugular plates. Paired fins obtusely lobate. Two dorsal fins and a single anal; the anterior dorsal without baseosts, obtusely lobate. Axial skeleton extending to the extremity of the caudal fin, usually projecting and terminated by a small supplementary caudal fin. Air-bladder ossified." (A. S. Woodward, *l. c.*, Pt. II, p. 394).

This family, first recognized by Professor Agassiz in the second volume of his Poissons Fossiles (1844, p. 168), and afterwards greatly restricted by Huxley in two important memoirs of the British Geological Survey (Decades X and XII, 1861 and 1866), is at present understood as comprising not more than six clearly defined genera, among which the most satisfactorily known are *Cœlacanthus* proper, *Macropoma*, and *Undina*. The typical genus enjoys a truly remarkable range from the Upper Devonian to the close of the Paleozoic, and if the evidence of one or two doubtful forms be deemed trustworthy, possibly even higher in the stratigraphic column. The remaining genera extend throughout the Mesozoic, and exhibit such constancy of structural characters that the group has been cited as one of the most distinct and sharply demarcated in the animal kingdom. Huxley, for instance, remarks upon its singular compactness and homogeneity in the following paragraph:

" The Cœlacanthini, as thus understood, are no less distinctly separated from other fishes than they are closely united to one another. In the form and arrangement of their fins, the structure of the tail and that of the cranium; the form and number of the jugular plates; the dentition; the dorsal interspinous bones; the pelvic bones, the ossified air-bladder; the Cœlacanthini differ widely from either the Saurodipterini, the Glyptodipterini, or the Ctenodipterini; but, on the other

hand, they agree with these families and differ from almost all other fishes, in the same respects as those in which the families just mentioned have been shown to agree with one another; viz., the number of the dorsal fins, the location of the paired fins, the absence of branchiostegal rays and their replacement by jugular bones."[6]

In a subsequent memoir the author whom we have just quoted speaks as follows regaring the extraordinary conservatism and persistence manifested by the group of Cœlacanth fishes ever since its introduction:[7]

"Bearing in mind the range of the Cœlacanths from the Carboniferous [since ascertained to extend from the Devonian] to the Chalk formations inclusive, the uniformity of organization of the group appears to be something wonderful. I have no evidence as to the structure of the base and side-walls of the skull in Cœlacanthus, but the data collected in the present Decade shows that, in every other particular, save the ornamentation of the fin-rays and scales, the organization of the Cœlacanths has remained stationary from their first recorded appearance to their exit. They are remarkable examples of what I have elsewhere termed 'persistent types,' and, like the Labyrinthodonts, assist in bridging over the gap between the Paleozoic and the Mesozoic faunæ."

The chief feature in which this family shows specialization is in the large symmetrical caudal fin, which exhibits a series of supports directly apposed to the neural and hæmal arches, equalling in number both these and the overlapping dermal rays. It is also specialized, as noted by Dr. A. S. Woodward,[8] in the following respects: (i) the fusion of the bones of the pterygoquadrate arcade; (ii) the reduction of the infradentaries to one; (iii) the reduction of the opercular apparatus to one operculum on each side and a pair of gular plates; (iv) the loss of the baseosts in the anterior dorsal fin; and (v) the ossification of the air-bladder.

Genus Undina Münster.

"Teeth absent on the margin of the jaws, but a few hollow, conical teeth within. Supplementary caudal fin prominent; the rays of all the fins broad and robust, often expanded, and closely articulated in the distal portion; small, upwardly-pointing denticles on the preaxial rays of the first dorsal and caudal fins. External

[6] Huxley, T. H., Preliminary essay upon the systematic arrangement of the Fishes of the Devonian Epoch, prefixed to the tenth decade of Figures and Descriptions illustrating British Organic Remains (1861, p. 20).

[7] Huxley, T. H., Illustrations of the Structure of the Crossopterygian Ganoids. Memoirs of the Geological Survey of the United Kingdom, Decade XII., 1866, and reprinted in the supplementary volume of the Scientific Memoirs of Thomas Henry Huxley, 1903, p. 65.

[8] Outlines of Vertebrate Palæontology, 1895, p. 78.

bones and scales superficially ornamented with tubercles or fine interrupted ridges of ganoine; parafrontal and circumorbital bones plate-like, without superficial excavations." (A. S. Woodward, *l. c.*, Pt. II, p. 409).

2. **Undina penicillata** Münster.

1834. *Undina penicillata* G. von Münster.
Neues Jahrb., p. 539.
1842. *Cœlacanthus striolaris* G. von Münster.
Neues Jahrb., p. 40.
1842. *Cœlacanthus kohleri* G. von Münster.
Ibid., p. 40.
1842 *Cœlacanthus striolaris* G. von Münster.
Beitr. Petrefakt., Pt. V, p. 57; pl. II, figs. 1, 3, 5, 6, 8, 9, 10, 12, 14, 16.
1844. *Undina striolatus* and *U. kohleri* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 171.
1863. *Undina penicillata* A. Wagner.
Abh. Math.-Phys. Cl., K. Bayer. Akad. Wiss., Vol. IX, p. 696.
1869. *Cœlacanthus penicillatus* R. von Willemoes-Suhm.
Palæontographica, Vol. XVII, p. 80; pl. X, figs. 2, 3; pl. XI, fig. 3.
1871. *Cœlacanthus harlemensis* T. C. Winkler.
Archives Mus. Teyler, Vol. III, p. 101; pl. IV.
1881. *Cœlacanthus harlemensis* B. Vetter.
Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 13; pl. II, fig. 4.
1887. *Undina penicillata* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 175, fig. 177.
1887. *Undina acutidens* K. A. von Zittel.
Ibid., p. 175, fig. 177*b* (fig. of scales only).
1888. *Undina penicillata* O. M. Reis.
Palæontogr., Vol. XXXV, pp. 30, 36; pl. II, figs. 5, 6, 9, 10; pl. IV, figs. 3, 4.
1888. *Undina acutidens* O. M. Reis.
Ibid., pp. 10, 36; pl. I, figs. 2–6, 8–24.
1891. *Undina penicillata* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. II, p. 410.

Type.—Nearly complete fish; Paleontological Museum, Munich.

"This species, which is the type of the genus, attains a length of about 40 cm. Trunk robust, but elongated; head and opercular apparatus occupying somewhat less than one-quarter of the total length. Fin-rays slightly expanded in the ar-

ticulated distal half; dorsal fins well developed, the first consisting of about ten relatively stout rays, the second and the anal each comprising at least twice that number of more slender rays; principal caudal fin comprising about eighteen to twenty stout rays above and below. Jugular plates four times as long as broad, covered with sparse elongated tubercles; operculum, cheek-plates, and mandible delicately tuberculated. Scales ornamented with numerous irregularly and closely arranged elongated tubercles." (A. S. Woodward, *l. c.*, Pt. II, p. 410).

The above synonymy and diagnosis are taken from A. Smith Woodward, who regards it as still doubtful whether the Cœlacanth remains described by Thiollière from the Upper Jura of Cerin, under the name of *Undina cirinensis* (Poiss. Foss. Bugey, pt. i, 1854, p. 10) are not identical with the type-species.

The status of the specific names hitherto applied to Cerin forms, namely *U. cirinensis* and *U. minuta*, will be readily understood from the following observations by Willemoes-Suhm (Palæontographica, 1869, Vol. XVII, p. 79):

"Thiollière beschreibt aus Cirin einen kleinen Cœlacanthus [= *Undina*] der sich von Münsters *penicillatus* nur dadurch unterscheidet, dass, während dieser oben 21 und unten 17–18 Strahlen in der Caudale zeigt, oben nur 15 und unten 13 vorhanden sind. Wagner fand nun unter den ebenfalls aus Cirin dem Münchener Museum eingesandten Fossilien einen sehr kleinen Cœlacanthen, der im Ganzen gut erhalten ist, doch den hintern Körpertheil von der zweiten Rückenflosse an verloren hat. Bei Aufstellung dieser Species legt er nun besonderes Gewicht auf die Kleinheit des gefundenen Exemplars die ihm als Charakter genügt. Ich kann mich dieser Ansicht nicht anschliessen. . . . Falls vollständigere kleinere Exemplare gefunden werden, wird sich vielmehr wahrscheinlich herausstellen, dass auch der *Coelacanthus minutus* zum Thiollières *Cœlacanthus cirinensis* gehört."

Thiollière's description of his so-called *Undina cirinensis* was published in 1854, and the small form named by Wagner *Undina minuta*, likewise from Cerin, was not described until 1863, hence Thiollière's name has priority, in case both are not synonyms of *U. penicillata*. The original of the French author's description is stated to have had a total length of 28 cm. and maximum depth of about 6 cm. Wagner's type was considerably smaller, and may well have been an immature individual. A much larger specimen of *Undina* than any hitherto made known, and one which presents differences apparently having specific value, is that described below.

3. **Undina grandis** sp. nov. (Plate XLVIII, fig. 2).

A large and imperfectly definable species, estimated to have equalled *U. gulo* in size, and differing from it and other described forms in the structure,

position, and ornamentation of the median fins. Anterior portion of the body unknown.

Type.—Posterior portion of large fish; Carnegie Museum, Cat. No. 4748.

It is unfortunate that the complete form of the body is unknown in the species under discussion, which is founded upon an imperfectly preserved and somewhat distorted caudal portion of a fish considerably exceeding *U. penicillata* in size, and approximating *U. gulo*. In so far as the number of rays supporting the lobes of the principal caudal fin may be relied upon as a differential character, the new species presents the following contrast to its congeners:

Name of Species.	Number of Caudal Fin-rays.
Undina gulo (Egerton)	16–18 above and below.
" *penicillata* Münster	18–20 " " "
" *cirinensis* Thiollière	15 " ; 13 "
" *grandis* Eastman	25 " ; 19 "

The supplementary caudal fin in the form under discussion is relatively shorter, that is, less produced backwards, than in other species, and comprises eleven flexed and articulated rays above and below. A noteworthy feature is that the rays of the principal caudal are provided along their expanded lateral surface with a series of minute conical denticles, similar to those occurring along the posterior border of the dorsal fin-rays of certain species of *Macrosemius*. The rays of all the fins are acutely pointed at their distal extremities. The posterior dorsal and anal fins comprise each about fifteen rays, are more acuminate than in other species, and arise nearer the base of the caudal fin. The position of the pelvic and pectoral pair is indicated in the type-specimen, and the pair of elongated and slender basipterygia, which are apparently fused, where they meet in an expanded distal process, are well displayed.

The axis is remarkably broad, tapers gradually posteriorly, but becomes expanded in the region of the articulated portion of the caudal fin-rays, after which it again tapers, being continued to the tip of the supplementary caudal fin. The lateral line is prominent, and runs parallel with the cartilaginous axis. None of the scales display the outer surface satisfactorily, but appearances suggest that the external ornament consisted of rather sparse and discontinuous ridges of ganoine, directed more or less longitudinally or slightly radiating. The covered portion of the scales is marked by numerous delicate concentric striæ crossed by another fine series having a fan-shaped arrangement. In *U. gulo* and *U. penicillata* the scales are externally ornamented with numerous closely spaced elongated tubercles; and in *U. cirinensis* the scale characters are thus described by the original author:

"Les écailles proprement dites sont à peu près indiscernables, bien qu'elles existent: ce qui tient à leur très-faible épaisseur; mais on reconnaît à la loupe, que la surface du corps est parsemée de petites épines fort aiguës, disposées par zones qui doivent correspondre au bord postérieur des écailles" (Thiollière, *l. c.*, p. 10).

Order **ACTINOPTERYGII.**

Suborder *PROTOSPONDYLI.*

Family SEMIONOTIDÆ.

"Trunk more or less deeply fusiform, rarely cycloidal. Cranial and facial bones all robust and opercular apparatus complete, but branchiostegals sometimes reduced; parietals meeting in the middle line; mandibular suspensorium vertical or inclined forwards, and gape of mouth small; teeth styliform or tritoral, especially well developed on the inner bones of the mouth, and with vertical successors. Notochord persistent, the vertebræ never advancing beyond the annular stage. Fin-rays robust, the majority well-spaced, articulated, and divided distally; fulcra large; dorsal fin not extending more than half the length of the trunk. Scales rhombic, except occasionally in the caudal region." (A. S. Woodward, *l. c.*, Pt. III, p. 49).

Genus Lepidotus Agassiz.

"Trunk fusiform and only moderately compressed. Marginal teeth robust, styliform, inner teeth stouter, often tritoral but smooth; opercular apparatus well-developed, with a narrow arched pre-operculum, but with few branchiostegal rays, and the gular plate wanting. Ribs ossified. Fin-fulcra very large, present on all the fins, biserial. Paired fins small; dorsal and anal fins short and deep, the former opposed to the space between the latter and the pelvic fins; caudal fin slightly forked. Scales very robust, smooth or feebly ornamented; flank-scales not much deeper than broad, with their wide overlapped margin produced forwards at the superior and inferior angles; scales of the ventral aspect nearly as deep as broad; dorsal and ventral ridge-scales usually inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, p. 77).

4. **Lepidotus lævis** Agassiz. (Plate XLVIII, Fig. 1).

1837–44. *Lepidotus lævis* L. Agassiz.

Poiss. Foss., Vol. II, Pt. I, p. 254; pl. XXIX*c*, figs. 4–6.

(?) 1846. *Lepidotus subundatus* G. von Münster (*errore*).

Beitr. Petrefakt., Pt. VII, p. 37; pl. III, fig. 16.

1860. *Lepidotus lævis* F. J. Pictet.

Descript. Rept. et Poiss. Foss. Jura Neufchâtelois, p. 26, Pls. VI, VII.

1875. *Lepidotus lævis* K. Fricke.

Palæontogr., Vol. XXII, p. 377; pl. XXI, fig. 1.

1895. *Lepidotus lævis* A. S. Woodward.

Cat. Foss. Fishes B. M., Pt. III, p. 103.

1908. *Lepidotus lævis* F. Priem.

Annales de Paléont., Vol. III, p. 10; Pl. I, fig. 1.

Type.—Scale; Museum of Soleure, Switzerland.

A robust species, attaining a length of about 75 cm., the proportions in general resembling those of *L. elvensis*, but with deeper body, the maximum depth being contained only about two-and-a-half times in the total length. External bones more or less rugose and ornamented with prominent and closely spaced tuberculations. Teeth short, stout, and smooth, the majority oval in outline, and sometimes showing a median coronal tubercle or apex; splenial teeth apparently in more than three concentric series. Scales large and smooth, none much deeper than long, except those of the middle of the flank anteriorly; principal flank-scales with a few broad ridges and furrows radiating from the center to the hinder border, where they form a distinct pectination; as many as forty-three transverse scale-rows from the region of the pectoral arch to the base of the caudal fin.

Until recently, no well-preserved examples of this species have been known from the lithographic stone of Cerin. In 1908, however, a very excellent specimen belonging to the Paris Museum of Natural History was described by Professor F. Priem, and one nearly as large and quite as well preserved forms part of the Bayet Collection of the Carnegie Museum, cataloged as No. 5130. In it all of the fins, with the exception of the dorsal and caudal, are tolerably well shown, and the cranial osteology is unusually well displayed. It will be profitable to compare the figure that is given of the head with Professor Priem's diagram (*l. c.*) showing the relation of the cranial and facial elements in the specimen studied by him.

Family MACROSEMIIDÆ.

"Trunk elongate, or elongate-fusiform, more or less laterally compressed. Cranial and facial bones moderately robust, or delicate, and opercular apparatus complete; mandibular suspensorium vertical or inclined forwards, and gape of mouth small; marginal teeth styliform, inner teeth similar or tubercular. Notochord persistent, the vertebræ never advancing beyond the annular stage. Fin-rays robust, the majority well-spaced, articulated and divided distally; fulcra

variable; dorsal fin elongated, usually extending at least half of the length of the trunk. Scales rhombic." (A. S. Woodward, *l. c.*, Pt. III, p. 163).

Genus Ophiopsis Agassiz.

"Trunk much elongated, gradually tapering from the occiput backwards or the dorsal margin only slightly arcuate; head large or of moderate size. Marginal teeth acutely pointed. Notochord invested with delicate ring-vertebræ; ribs ossified. Bifurcation of dorsal fin-rays variable; fulcra often absent on paired fins and usually confined to the base of the median fins. Paired fins relatively large; dorsal fin ordinarily extending about half the length of the back, high in front, low behind; anal fin small; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and often pectinated at the hinder border; the scales at the middle of the flank scarcely deeper than broad, few of the ventral scales much broader than deep; no enlarged ridge-scales." (A. S. Woodward, *l. c.*, Pt. III, p. 165–6).

5. **Ophiopsis attenuata** Wagner.

1863. *Ophiopsis attenuata* A. Wagner.
Abhandl. K. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 655.
1873. *Ophiopsis attenuata* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 19; pl. VIII, fig. 2.
1895. *Ophiopsis attenuata* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 167; pl. III, figs. 2, 3.

Type.—Trunk of fish; Paleontological Museum, Munich.

A species attaining a length of about 15 cm. Length of head with opercular apparatus equalling the maximum depth of the trunk, and contained about five times in the total length of the fish; maximum depth of trunk twice as great as the width of the caudal pedicle. External head-bones and opercular bones smooth. Dorsal fin occupying about one-half of the length of the back, the length of the dorsal fin-rays rapidly decreasing in a posterior direction, and most of them undivided. Scales delicately serrated, not pectinated.

This species is represented in the Carnegie Museum by two average-sized and tolerably well-preserved individuals, cataloged under the numbers 4041 and 4422.

6. **Ophiopsis guigardi** Thiollière.

1873. *Ophiopsis guigardi* Thiollière.
Poiss. Foss. Bugey, Pt. II, pl. VII (figure only).

1895. *Ophiopsis guigardi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 169.

"*Type*.—Nearly complete fish; Lyons Museum.

A species attaining a length of about 30 cm. Length of head with opercular apparatus equal to the maximum depth of the trunk and contained about five-and-a-half times in the total length of the fish; maximum depth of trunk twice as great as the depth of the caudal pedicle. Fin-fulcra slender, extending up the anterior ray of each median fin. Dorsal fin less than half as long as the back, much elevated in front, arising at the beginning of the second third of the trunk. Scales relatively large and smooth." (A. S. Woodward, *l. c.*, Pt. III, p. 169).

This is a rare form, known only from Cerin, and is not represented in the Bayet Collection.

7. **Ophiopsis macrodus** Thiollière. (Plate LI, fig. 2).

1850. *Ophiopsis macrodus* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2] Vol. III, p. 148.

1873. *Ophiopsis macrodus* Thiollière.

Poiss. Foss. Bugey, Pt. II, p. 19.

1895. *Ophiopsis macrodus* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 172.

Type.—Nearly complete fish; Lyons Museum.

A much elongated species of small size, attaining a total length of about 18 cm. Length of head with opercular apparatus equal to the maximum depth of trunk, and contained about five times in the total length; width of caudal pedicle half as great as the maximum depth of trunk. Head and opercular bones smooth, teeth elongate-conical, of relatively very large size and widely spaced. Dorsal fin low, not much extended, and arising at a point about opposite the pelvic pair. Fin-fulcra slender on all the fins, none of which is strongly developed. Scales smooth and relatively small, with entire posterior borders, and in numerous vertical series.

This species has been briefly described but not previously illustrated, and would appear to be a rare form. From the type species, *O. procera*, it is distinguished by the following characters, as noted by the original author:

"L'espèce nouvelle . . . me parait différer de l'*O. procerus* en ce que les dents en sont beaucoup plus fortes et la dorsale bien moins vigoureuse. Les écailles de l'*O. macrodus* ne sont pas, non plus, aussi uniformes que celles de l'espèce de Solenhofen."

A single example of this species is preserved in the Bayet Collection of the Carnegie Museum. It is cataloged as No. 4104, and is shown in the plate. A small example of *Notagogus* is contained in the same slab.

Genus Histionotus Egerton.

"Head large, snout acute; the dorsal margin of the trunk rising above the head to an angulation from which the body gradually tapers backwards. Marginal teeth much elongated, closely arranged. Notochord invested with delicate ring-vertebræ. Fins consisting of distally bifurcating rays, all with large Λ-shaped fulcra; pectoral fins much larger than the pelvic pair; dorsal fin arising at the angulation of the back, extending to the caudal pedicle, high in front, becoming low behind; anal fin small; caudal fin forked. Scales covering the whole of the trunk, in regular series, united by peg-and-socket articulation, and more or less pectinated at the hinder border; [the scales of the middle of the flank and of the dorsal region much deeper than broad, with more or less convex hinder border—*Eastman*]; those of the ventral region at least as broad as deep; postclavicular scales very large; the ridge scales of the caudal pedicle not much enlarged." (A. S. Woodward, *l. c.*, Pt. III, pp. 173–4).

8. **Histionotus falsani** Thiollière. (Plate XLIX, fig. 1).

1873. *Histionotus falsani* Thiollière.

Poiss. Foss. Bugey, Pt. II, p. 14; pl. V, fig. 1.

1895. *Histionotus falsani* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 175.

Type.—Much fractured fish; Lyons Museum.

A species about equalling the type of the genus in size, but the maximum depth of the trunk somewhat exceeding half its length, and the head with opercular apparatus at least as deep as long. Marginal teeth strong and conical, closely crowded. Fulcra prominent on all the fins; scales delicately pectinated along their posterior border.

This species was at first regarded by the original author as identical with *H. angularis* Egerton from the Purbeck of Dorset and Wiltshire. It differs from the latter form, however, and also from *H. oberndorferi* of Wagner, in the less acute angulation of the back, less rapidly tapering posterior region of the trunk, and less coarsely serrated character of the scales.

A single representative of this species, preserved in the collection of the Carnegie Museum, is shown in the plate and is No. 4077. It is nearly as large as the type of the genus, and presents the appearance of having a discontinuous dorsal fin. The resemblance to *Histionotus* in other respects, however, is too close to permit us to doubt that it is properly referred to this genus.

Genus Macrosemius Agassiz.

"Trunk gradually tapering from the occiput backwards; head large, snout acute. Teeth much elongated, closely arranged. Notochord persistent, without ring-vertebræ; ribs ossified. Fins consisting of very robust, bifurcating rays, without fulera except in the caudal; pectoral fins much larger than the pelvic pair; dorsal fin arising immediately behind the occiput and extending continuously to the caudal pedicle; anal fin small; caudal fin rounded. Scales thin and more or less pectinated, with peg-and-socket articulation, and apparently wanting towards the dorsal margin; scales of the middle of the flank relatively large, becoming smaller both dorsally and ventrally, in the former case by dichotomy of the vertical series; about four very large ridge-scales on the ventral border between the anal and caudal fins." (A. S. Woodward, *l. c.*, Pt. III, pp. 176–7).

Three species of *Macrosemius* have been described from the lithographic stone of Cerin under the following names: *M. dumortieri*, *M. fourneti*, and *M. helenæ* Thiollière, the last-named imperfectly defined. A single fragmentary specimen, catalogued as No. 4034, and probably belonging to this genus, is contained in the Bayet Collection.

Genus Notagogus Agassiz.

"A genus scarcely distinguished from *Propterus*, differing only in the non-elongation of the anterior rays of the dorsal fin, which are very widely spaced, and in the less deeply forked character of the caudal fin. The vertebral rings also appear to be more robust than in *Propterus*." (A. S. Woodward, *l. c.*, Pt. III, p. 186).

9. **Notagogus inimontis** Thiollière. (Plate XLIX, fig. 2; Plate L, figs. 1, 2).

1850. *Notagogus imimontis* Thiollière.
Ann. Soc. Sci. Phys. et Nat. Lyon [2] Vol. III, p. 137.

1858. *Notagogus iunismontis* Thiollière.
Bull. Soc. Géol. France [2], Vol. XV, p. 783 (Name only).

1873. *Notagogus inimontis* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 15; pl. VI, fig. 3.

1893. *Notagogus inimontis* H. E. Sauvage.
Bull. Soc. Hist. Nat. Autun, Vol. VI, p. 428.

1895. *Notagogus inimontis* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. 3, p. 188.

Type.—Nearly complete fish; Lyons Museum.

A small species having about the same form and proportions as *N. denticulatus*,

but distinguished from the latter by its relatively larger teeth and the steeper facial profile of the head. The two portions of the dorsal fin about equally elevated, each with about nine rays, those of the posterior portion more closely approximated than those of the anterior portion. Fulcra well developed on all the median fins. Scales prominently denticulated along the hinder border.

This species is represented in the collections of the Carnegie Museum by several specimens, catalogued under the following numbers: 4033, 4035, 4399, 4418, 4654, 5115, and 5516. The one catalogued as No. 4399 is of unusually large size, approaching that of average specimens of *N. pentlandi*. It bears considerable resemblance to the undescribed form figured by Thiollière under the name of *I. margaritæ*.

10. **Notagogus ornatus** sp. nov. (Pl. L, fig. 3.)

Type.—Nearly complete fish in counterpart; Carnegie Museum Cat. No. 5114 +5114*a*.

A species attaining a length of about 14 cm., of robust proportions and with gently arched dorsal and ventral contours, the length of the head and opercular apparatus equalling the maximum depth of the trunk and contained two and one-half times in the total length, exclusive of the caudal fin. External bones of the head ornamented with delicate striæ, or sometimes with fine vermiculating rugæ. A circumorbital ring present. Jaws powerful, teeth stout, conical, and closely spaced. Dorsal fin extended, but not much elevated, the anterior portion comprising thirteen, and the posterior nine rays. Anal fin arising opposite the hinder part of the posterior dorsal, well developed, and with about eight rays. Caudal fin not deeply forked. Fulcra present on all the median fins.

Scales with numerous fine obliquely directed pectinations along their hinder border; about thirty-six vertical series are to be counted along the lateral line, which is distinctly indicated, and twelve longitudinal series in the deepest part of the trunk. Scales of the pectoral region sharply differentiated by their smaller size and almost cycloidal form from those covering the flanks and abdominal region. A few enlarged ridge-scales at the base of the tail above and below and in advance of the anal fin.

This species is distinguished from *H. inimontis* and the imperfectly known *H. margaritæ*, which accompany it in the Cerin locality, by its larger size, the deeper contour of the body, more numerous dorsal fin-rays, and, as far as may be judged from the published figures of the above-named species, by its scale-characters. Three examples of it are contained in the Bayet Collection of the Carnegie Museum, cataloged as Nos. 5114+5114*a*, 4071, and 4660+4660*a*. The first of these is selected as typical.

Family PYCNODONTIDÆ

"Trunk deeply fusiform or cycloidal. Cranial bones robust, and a median occipital plate separating the parietal elements; facial bones delicate, or wanting; opercular apparatus reduced to a small operculum, large pre-operculum, and not more than two branchiostegal rays; mandibular suspensorium much inclined forwards and gape of mouth small; teeth prehensile on the premaxilla and dentary, wanting on the maxilla (if this bone be present) and the pterygo-palatine arcade; tritoral on the single vomer and the splenials; all the teeth apparently without vertical successors. Notochord persistent, destitute of ossifications in its sheath. Fin-rays robust, the majority well-spaced and articulated; fulcra absent, except perhaps quite at the base of the caudal fin; dorsal and anal fins more or less extended. Scales rhombic when present, frequently wanting on the whole or part of the caudal region; almost invariably strengthened by the inner rib on their anterior margin and united by a peg-and-socket articulation in connection therewith." (A. S. Woodward, *l. c.*, Pt. III, pp. 189–190).

Genus Microdon Agassiz.

"Trunk deeply fusiform, often almost discoidal, with a slender abbreviated caudal pedicle. Head and opercular bones ornamented with reticulating rugæ and pittings; teeth smooth, sometimes feebly indented in the lateral series; vomerine teeth in five longitudinal series, the inner lateral pairs regularly alternating with the widely spaced median teeth; splenial teeth in four series; the innermost being relatively small; the second the largest or principal series. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the notochord. Fin-rays robust, closely articulated, and much divided distally. Pelvic fins present; dorsal and anal fins very high and acuminate in front, rapidly becoming low and fringe-like behind, the former occupying at least the hinder half of the back and the latter somewhat shorter, arising more posteriorly; caudal fin forked. Scales ornamented with reticulating rugæ or pittings, and covering only the anterior half of the trunk in advance of the median fins, though sometimes partly extended over the middle of the flank of the caudal region." (A. S. Woodward, *l. c.*, Pt. III, pp. 221–2).

The type of the genus is *M. elegans* Agassiz.

11. **Microdon bernardi** (Thiollière). (Plate LII, figs. 1 and 2.)

1854. *Pycnodus bernardi* Thiollière.

Poiss. Foss. Bugey, pt. i, p. 17, with plate.

1856. *Microdon bernardi* J. J. Heckel.

Denkschr. K. Akad. Wiss. Wien. Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon bernardi* Wagner.

Gelehrte Anzeig. K. Bayer. Akad. Wiss., Vol. I, p. 396.

1895. *Microdon bernardi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 224.

Type.—Nearly complete fish; Lyons Museum.

A species attaining a total length of about 30 cm. "Maximum depth of trunk equalling about two-thirds of the length of the head and trunk without caudal fin; rostrum prominent, and head with opercular apparatus occupying somewhat less than one-quarter of the total length of the fish. Vertebral axis at origin of dorsal fin midway between the dorsal and ventral borders of the fish. Principal series of mandibular teeth much wider than the two outer series, of which the innermost is insignificant. Dorsal fin occupying considerably more than half of the back, much more elevated than the anal fin, which is also shorter. Ridge-scales delicate on the back, robust but feebly serrated on the ventral border; flank-scales ornamented with delicate radiating rugæ." (A. S. Woodward, *l. c.*, Pt. III, pp. 224–5).

This species is represented in the collection by the following mentioned specimens: Car. Mus. Cat. Nos. 4040, 4084a, 5118, 5132.

12. **Microdon wagneri** (Thiollière). (Pl. LIII, figs. 1 and 2).

1854. *Pycnodus wagneri* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 23; Pl. V, figs. 1, 2.

1856. *Microdon wagneri* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon wagneri* Wagner.

Gelehrte Anzeig. K. Bayer. Akad. Wiss., Vol. I, p. 396.

1895. *Microdon wagneri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 225.

Type.—Nearly complete fish; Lyons Museum.

"A species resembling the type, in size, general form, and proportions, and apparently only differing in the extension of the squamation over the middle of of the flank of the anterior half of the caudal region." (A. S. Woodward, *l. c.*, Pt. III, p. 225).

The following mentioned specimens belonging to this species are preserved in the collection of the Museum: Car. Mus. Cat. Nos. 4078, 4090, 4306, 4320.

13. **Microdon egertoni** (Thiollière). (Pl. LIV, fig. 1.)

1854. *Pycnodus egertoni* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 24, Pl. VII, fig. 2.

1856. *Microdon egertoni* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon egertoni* A. Wagner.

Gelehrte Anzeig. K. Bay. Akad., Vol. I, p. 396.

1895. *Microdon egertoni* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 226.

Type.—Nearly complete fish; Lyons Museum.

A species of small or moderate size, closely resembling *M. elegans*, but stated to be distinguished from it in not exhibiting any angulation of the frontal profile, and in having fewer vertebræ. As remarked, however, by Dr. A. S. Woodward, the first character "may be due to imperfect preservation, and the second is difficult to observe with certainty" (*l. c.*, p. 226).

The following suite of specimens belonging to this species is contained in the collection of the Carnegie Museum: Nos. 4085, 4557, 5106, 5107.

14. **Microdon sauvanausi** (Thiollière). (Plate LIV, fig. 2.)

1850. *Pycnodus sauvanausi* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2], Vol. III, p. 131.

1854. *Pycnodus sauvanausii* Thiollière.

Poiss. Foss. Bugey., Pt. I, p. 15, Pl. IV.

1856. *Microdon sauvanausii* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1895. *Microdon sauvanausi* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 226.

Type.—Nearly complete fish; Lyons Museum.

"A large species attaining a length of about 60 cm. Maximum depth of trunk apparently equalling about half of the length of the head and trunk without caudal fin; head with opercular apparatus occupying somewhat more than one-quarter of the total length of the fish. Each premaxilla with two chisel-shaped teeth, [other teeth imperfectly known]. Scales apparently confined to the more anterior part of the trunk." (A. S. Woodward, *l. c.*, Pt. III, pp. 225–6).

This species is represented in the Bayet Collection of the Carnegie Museum by a single specimen of moderate size, fairly well preserved, with the exception of the anterior part of the head, and cataloged as No. 4666. This and the next

following species are of interest because they acquaint us with stages showing progressive deepening of the trunk with increasing specialization, *M. itieri* being regarded as a survival of a more primitive type, in which the form of body was elongated and but slightly deepened. A parallel series of modifications is furnished by the genera *Lepidotus* and *Dapedius* among the Semionotidæ, and by typical members of the Palæoniscidæ and Platysomidæ in earlier times.

It is evident that the deep-bodied forms were not adapted for rapid locomotion, and, as indicated by the prevailing type of crushing dentition, they were in all probability bottom-feeders. The large size of the orbits in certain genera occurring at the Solenhofen and Cerin localities suggests that they were probably inhabitants of great depths. Abundant evidence exists, as shown by Dr. Walther and others, to prove that the lithographic stone of Bavaria and southeastern France was deposited under shallow-water conditions, often within lagoons of coral atolls. The presence of a few deep-sea types amid a fauna consisting for the most part of shallow-water inhabitants does not militate against the general theory of the origin of these deposits, but merely bears witness to the fact that the total complex was diversified from time to time by occasional stragglers from outlying regions.

The following remarks by Dr. E. Hennig may be appropriately quoted in connection with this subject:

" Die Pyknodonten sind, nach einem Ausdruck Agassiz's, *poissons broyeurs*, d.h. ihre Nahrung bestand aus Krustazeen, Muscheln, und Schnecken. Die einander entsprechend gewölbten Kauplatten des Ober- und Unterkiefers mit ihren kräftigen, meist in geschlossenen Reihen gestellten Mahlzähnen und die ungewöhnlich starke Abkauung weisen ebenso darauf hin wie die Heranziehung der gesamten unteren Kopfhälfte zur Festigung des Gebisses und die darin zum Ausdruck kommende Konvergenz mit dem lebenden *Anarrhichas lupus*. Auch die weitgehende Differenzierung der Zähne und die zu vermutende Ausschaltung eines häufigeren Zahnwechsels machen eine starke Inanspruchnahme der Kauwerkzeuge in hohem Maase wahrscheinlich.

" Die Beute bestand also auf festsitzenden oder langsam kriechenden Bewohnern des Meeresgrundes und wurde mit den langen und kräftigen Schneidezähnen losgerissen und aufgelesen. Mit dem Aufenthalt zwischen Unebenheiten des Bodens wurde bereits das Aufwärtsrücken des Auges in Verbindung gebracht; auch die hohe Lage der Brustflossen und die Verkümmerung der Bauchflossen dürften in der gleichen Ursache ihre Erklärung finden. Die Grösse der Augen scheint sogar anzudeuten, das die Tiefe, in der die Tiere sich aufhielten, keine unbeträchtliche war. Wenn man auch nicht mit O. Fraas anzunehmen braucht,

dass die lithographischen Schiefer selbst in grösserer Tiefe abgesetzt seien, so stände doch nach der Walterschen Erklärung der Solnhofener Plattenkalke nichts der Ansicht entgegen, dass die[9] Fische aus tieferen Gewässern der Nachbarschaft eingeschleppt worden sind."

15. **Microdon itieiri** (Thiollière).

1850. *Pycnodus itieri* Thiollière.

Ann. Soc. Sci. Phys. et Nat. Lyon [2], Vol. III, p. 132.

1854. *Pycnodus itieri* Thiollière.

Poiss. Foss. Bugey, Pt. I, p. 22, Pl. VI, and two text-figures, p. 23.

1856. *Microdon itieri* J. J. Heckel.

Denkschr. K. K. Akad. Wiss. Wien, Math-Natur. Cl., Vol. XI, p. 201.

1860. *Microdon itieri* A. Wagner.

Gelehrte Anzeig. K. K. Akad. Wiss., Vol. L, p. 396.

1895. *Microdon itieri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 227.

Type.—Nearly complete fish; Lyons Museum.

"A moderately elongated species, attaining a total length of about 50 cm. Maximum depth of trunk contained three times in the length of the head and trunk without caudal fin; head with opercular apparatus occupying only about one-fifth of the total length of the fish. Vomerine teeth closely arranged; those of the median series much broader than long; those of the inner paired series elongated and their axes oblique, each pair alternating with the median teeth but scarcely pressed between these; outer teeth irregularly quadrate, about as broad as long, and very closely arranged. Splenial teeth (according to Thiollière's diagram) much spaced; those of the principal series two or three times as broad as long, rounded at each end; those of the innermost series minute, and those of the two flanking series somewhat broader than long, the outer twice as large as those of the inner flanking row. Dorsal fin occupying about half of the back, and anal fin more than two-thirds as much extended as this. Scales apparently confined to the most anterior portion of the trunk." (A. S. Woodward, *l. c.*, Pt. III, p. 227).

The form of the body of this species indicates it to be one of the most primitive of the genus and family, possibly a direct descendant of an ancestral type of Pycnodont. It is known only from Cerin, and is not represented in any other than the Lyons Museum.

[9] Hennig, Erwin. Gyrodus und die Organisation der Pycnodonten. Paleontogr., 1906, Vol. LIII, p. 200.

In Part I of Thiollière's Poissons Fossiles de Bugey, p. 23, diagrams are given showing the complete dentition of this species. Several examples of the detached upper and lower dental plates, perhaps referable to this species, are preserved in the collection of the Carnegie Museum, and the most perfect of these is shown of the natural size in the accompanying text-figure.

Fig. 2. Detached splenial dentition of a Pycnodont fish from Cerin, France, provisionally referred to *Microdon itieri* Thioll. × 1/1. Cat. No. 4241.

Family EUGNATHIDÆ.

"Trunk fusiform or elongate, not much laterally compressed. Cranial and facial bones moderately robust, externally enamelled, and opercular apparatus complete; mandibular suspensorium nearly vertical or inclined backwards and gape of mouth wide; snout not produced; premaxillæ in contact mesially and usually separate; marginal teeth conical, and larger than the inner teeth. Notochord usually persistent, the vertebræ rarely more than incomplete rings. Fin-rays robust, articulated, and divided distally; fulcra conspicuous. Dorsal fin short and acuminate. Scales rhombic, sometimes with rounded postero-inferior angle." (A. S. Woodward, *l. c.*, Pt. III, p. 285).

Genus Caturus Agassiz.

"Trunk elongate-fusiform. External head-bones and opercular bones feebly ornamented with rugæ and tuberculations, all except the cheek-plates robust; snout obtusely pointed, and maxilla straight or with a slightly concavely-arched dentigerous border; teeth relatively large and arranged in a sparse series on the margin of the jaws; smaller on the palatine and on the splenial, where they are in single series anteriorly, minute and almost granular on the other inner bones; preoperculum nearly smooth and narrow; operculum deep, much broader below than above, and suboperculum of moderate size. Ossifications in the sheath of the notochord insignificant or absent in the smaller species, consisting only of separate hypocentra and pleurocentra in the largest species; ossified ribs slender, not reaching the ventral border of the abdomen. Fulcra biserial, well-developed on all the fins, those of the pectoral being especially elongated and sometimes in part fused together. Pectoral much exceeding the pelvic fins in size, but the

latter well-developed; dorsal and anal fins triangular in shape, the former arising opposite or immediately behind, the pelvic fins; caudal fin deeply forked. Scales delicate, smooth, feebly crimped or in part tuberculated, deeply overlapping, and none much deeper than broad; a few series anteriorly quadrangular and possibly sometimes united with peg-and-socket, the others more or less cycloidal, and very few narrowed on the ventral aspect of the fish. Lateral line inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, pp. 329–330).

16. **Caturus furcatus** Agassiz. (Plate LV, fig. 1.)

1833. *Pachycormus furcatus* L. Agassiz.
Neues Jahrb., p. 476, and Poiss Foss., Vol. II, Pt. I, p. 11.
1833. *Urœus nuchalis* L. Agassiz.
Neues Jahrb., p. 477, and Poiss. Foss., Vol. II, Pt. I, p. 12.
1834. *Caturus latus* G. von Münster.
Neues Jahrb., p. 539.
1834. *Urœus furcatus* L. Agassiz.
Verhandl. Ges. Vaterländ. Mus. Böhmen, p. 70.
1839. *Caturus maximus* and *macrodus* L. Agassiz.
Neues Jahrb., p. 118.
1839–44. *Caturus latus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 117; pl. LVI.
1842–44. *Caturus furcatus* L. Agassiz.
Ibid., Pt. II, p. 116; pl. LVI*a*.
1844. *Caturus maximus* and *macrodus* L. Agassiz.
Ibid., Pt. II, pp. 118, 294.
1844. *Caturus nuchalis* L. Agassiz.
Ibid., Pt. II, p. 293.
1863. *Caturus maximus* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math-Phys. Cl., Vol. IX, p. 700.
1863. *Caturus furcatus* A. Wagner.
Ibid., p. 701.
1863. *Caturus latus* and *cyprinoides* A. Wagner.
Ibid., p. 702.
(?) 1873. *Caturus furcatus* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 18; pl. XIII, fig. 1.
(?) 1873. *Caturus latus* Thiollière.
Ibid., p. 18, pl. XIII, fig. 3.

1881. *Caturus furcatus* B. Vetter.
Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 109.
1887. *Caturus maximus* K. A. von Zittel.
Handb. Palæont., Vol. III, p. 228, fig. 241 *a*.
1887. *Caturus furcatus* K. A. von Zittel.
Ibid., p. 228, figs. 241 *b–g*.
1887. *Caturus elongatus* K. A. von Zittel.
Ibid., p. 227, fig. 240 (*errore*).
1895. *Caturus furcatus* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 332.

According to the last-named author, the small fishes described under the following names also appear to be immature examples of this species:

1833. *Urœus macrurus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 12.
1839. *Caturus microchirus* L. Agassiz.
Neues Jahrb., p. 118.
1842. *Caturus obovatus* G. von Münster.
Neues Jahrb., p. 44.
1844. *Caturus macrurus* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, p. 118.
1844. *Caturus microchirus* L. Agassiz.
Ibid., pp. 118, 294.
1861. *Caturus ferox* Winkler.
Descript. Poiss. Foss. Solenhofen (Natuurk., Verhandl. Holland. Maatsch. [2], Vol. XIV, p. 56, fig. 10).
1863. *Caturus microchirus* A. Wagner.
Abh. K. Bayer. Akad. Wiss., Math-Phys. Cl., Vol. IX, p. 703.
1863. *Caturus macrurus* A. Wagner.
Ibid., p. 706.
1863. *Caturus obovatus* and *gracilis* A. Wagner.
Ibid., p. 707.
1871. *Caturus ferox* Winkler.
Archiv. Mus. Teyler, Vol. III, p. 176; pl. V, figs. 2, 3.

Type.—Nearly complete fish; Royal Bohemian Museum, Prague.

"The type-species attains a length of about one meter. Length of head with opercular apparatus about equal to the maximum depth of the trunk and usually less than one-quarter of the total length of the fish. Caudal region tapering to a

comparatively slender pedicle; its depth little, if at all, exceeding one-third the maximum depth of the abdominal region. Teeth large, with very slender apex, and about forty in total number in the dentary; depth of operculum somewhat exceeding its maximum breadth; branchiostegal rays about twenty-four. Dorsal fin with about twenty rays, deeper than long, its depth equalling about one-half that of the trunk at its origin; this fin arising in advance of the middle of the back, the distance from the occiput to its origin being about equal to that from its hinder border to the base of the caudal fin. Pelvic fins arising opposite the front half of the dorsal fin; anal fin smaller than the dorsal, with from twelve to fourteen rays. Scales smooth, or in part marked with a few feeble, short, transverse striæ." (A. S. Woodward, *l. c.*, Pt. III, p. 333).

The specimens listed below agree with those from Cerin, which are assigned to this species by Thiollière, but the identity of which with the type-species is regarded by Dr. A. S. Woodward as somewhat uncertain: Nos. 4062, 4064, 4074, 4074*a*, 4097, 4300, 4301, 4302, 5108.

17. **Caturus driani** Thiollière.

18. **Caturus velifer** Thiollière.

The two foregoing are large species, occurring in the lithographic stone of Cerin, France, known only by a few examples, and not represented in the collection of the Carnegie Museum, except by one or two obscure fragments (Cat. No. 4089). It may be remarked here that the genus *Callopterus*, two species of which have been described from the Lower Kimmeridgian of Ain, France, is very closely related to *Caturus*, differing only in the more remote position of the dorsal fin, which is almost completely opposed to the anal. No examples of *Callopterus* are preserved in either the British or the Carnegie Museums.

Suborder ÆTHEOSPONDYLI.

"Notochord varying in persistence, but pleurocentra and hypocentra usually fused, never forming alternating discs or rings; tail abbreviate-heterocercal or homocercal. Mandible complex, with well-developed splenial rising into a coronoid process, which is completed by a distinct coronoid bone. Infra-clavicular plates wanting in the pectoral arch; pectoral fin with more than five basals. Scales ganoid." (A. S. Woodward, *l. c.*, Pt. III, p. 415).

Family ASPIDORHYNCHIDÆ.

"Head and trunk much elongated, the snout produced, and the abdominal much longer than the caudal region; tail homocercal. Cranial and facial bones

robust, and opercular apparatus complete, all more or less ganoid, mandibular suspensorium vertical or inclined forwards, but gape of mouth wide; a distinct azygous presymphysial bone present in the mandible; marginal teeth slender, conical. Branchiostegal rays numerous. Vertebral centra annular or amphiocœlous. Fins small, with broad, flattened rays, branched and articulated distally; fulcra minute or absent. Scales rhombic, much deepened on the flank." (A. S. Woodward, *l. c.*, Pt. III, p. 415).

This family, which perhaps may be regarded as ancestral to the modern garpikes (Lepidosteidæ) comprises two genera, which are distinguished by the following differential characters:

"Synopsis of Genera.

Rostrum much produced in advance of mandibular symphysis, and intercalary cheek-plate between the suborbitals and preoperculum; foremost scales of lateral line not deeper than those immediately beneath . . . . . *Aspidorhynchus.*

Rostrum scarcely if at all produced in advance of mandibular symphysis; suborbitals in contact with preoperculum; all scales of lateral line deeper than those immediately beneath. . . . . *Belonostomus.*" (A. S. Woodward, *l. c.*, Pt. III, p. 415).

Genus Belonostomus Agassiz.

"Snout very slender, scarcely if at all produced in front of the extremity of the much-elongated presymphysial bone; cheek-plates robust, the postorbitals extending to the anterior border of the preoperculum; the conical teeth irregular in size, largest on the hinder part of the premaxillæ and the median line of the presymphysial bone, obtuse on the splenial and reduced to a fine granulation on the inner face of the ectopterygoid. Ossified vertebræ usually pierced by a remnant of the notochord. Fin-rays distally bifurcating; fulcra wanting on paired fins, rare on median fins. Pelvic fins situated near the middle of the trunk; dorsal and anal fins short-based, triangular, remote and opposed; caudal fin symmetrically forked. Scales robust, smooth or rugose; in three deepened series on the flank of the abdominal region, and the series traversed by the lateral line the deepest; dorsal scales between the flank scales and the median ridge in two series." (A. S. Woodward, *l. c.*, Pt. III, p. 498).

19. **Belonostomus muensteri** Agassiz. (Plate LV, figs. 2 and 3).

1834. *Aspidorhynchus münsteri* L. Agassiz.

Verhandl. Ges. vaterländ. Mus. Böhmen, p. 70 (name only).

1837. *Belonostomus münsteri* L. Agassiz.

Bericht Versamml. deutsch. Naturf., Jena, 1836, p. 127 (name only).

1844. *Belonostomus münsteri* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, pp. 141, 297, pl. XLVIIa, fig. 2.
1848. *Belonostomus muensteri* C. G. Giebel.
Fauna der Vorwelt, Fische, p. 155.
1861. *Belonostomus münsteri* T. C. Winkler.
Descript. Poiss. Foss. Solenhofen (Natuurk. Verhandl. Holland. Maatsch. [2] Vol. XIV) p. 34, fig. 5.
1863. *Belonostomus münsteri* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 689.
1863. *Belonostomus speciosus* A. Wagner.
Ibid., p. 689.
1887. *Belonostomus speciosus* O. Reis.
Sitzungsber. Bay. Akad. Wiss., Math.-Phys. Cl., Vol. XVII, p. 159, pl. I, fig. 4.
1895. *Belonostomus muensteri* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 429.

"*Type.*—Head and anterior part of trunk; British Museum.

A species of moderate size attaining a length of about 40 cm. Head with opercular apparatus occupying about one-quarter of the total length; maximum depth of trunk contained fifteen times in the total length. Cranium about five times as long as its maximum depth, jaws equal in length, the pointed anterior extremity of the dentary bones suturally united with a deep re-entering angle in the pre-symphysial bone; external ornament very finely rugose. Vertebræ in the form of robust constricted rings, longer than deep. Space between the origin of the pelvic fins and that of the anal fin about equal to the space between the latter and the caudal. Scales finely tuberculated, partly rugose; those of the lateral line not much exceeding in depth the series below." (A. S. Woodward, *l. c.*, Pt. III, p. 430).

This species is represented in the collection of the Carnegie Museum by several well-preserved specimens, cataloged under the following numbers: Car. Mus. Cat., Nos. 4043, 4321, 4343, 4653, 5112, 5113, 5133. A distorted and indistinct impression of the trunk belonging to this or a closely related species is cataloged as No. 4068.

20. **Belonostomus tenuirostris** Agassiz. (Plate LI, fig. 3).

1833. *Aspidorhynchus tenuirostris* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 14.
1834. *Belonostomus tenuirostris* L. Agassiz.
Neues Jahrb., p. 388.

1837. *Belonostomus tenuirostris* L. Agassiz.
Bericht Versamml. deutsch. Naturf., Jena, 1836, p. 127.
1837. *Belonostomus tabulatus* L. Agassiz.
Ibid., p. 127 (name only).
1844. *Belonostomus tenuirostris* L. Agassiz.
Poiss. Foss., Vol. II, Pt. II, pp. 143, 297.
1844. *Belonostomus subulatus* L. Agassiz.
Ibid., pp. 143, 297.
1863. *Belonostomus tenuirostris* A. Wagner.
Abh. K. Bay Akad. Wiss., Math.-Phys., Cl., Vol. IX, p. 691.
1863. *Belonostomus tenuirostris* var. *brevivertebralis* A. Wagner.
Ibid., p. 691.
1873. *Belonostomus tenuirostris* V. Thiollière, *ed.* P. Gervais.
Poiss. Foss. Bugey, Pt. II, p. 24.
1881. *Belonostomus tenuirostris* B. Vetter.
Mittheil. K. Mineral-geol. Mus. Dresden, Pt. IV, p. 85.
895. *Belonostomus tenuirostris* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 431.
1912. *Belonostomus tenuirostris juv.* C. R. Eastman.
Ann. Carnegie Mus., Vol. VIII, p. 184, pl. X.

Type.—Incomplete fish; present location unknown.

"A species of very slender proportions attaining a length of about 30 cm. Head with opercular apparatus occupying one-third of the total length; maximum depth of trunk contained fourteen times in the total length. Cranium about nine times as long as its maximum depth, having the snout excessively elongated and projecting to some extent in advance of the anterior extremity of the mandible; the pointed front end of the dentary bones suturally united with a deep re-entering angle in the pre-symphysial bone; superficial ornament consisting of delicate rugæ. Vertebræ in the form of separated narrow rings, much deeper than broad. Scales smooth or feebly tuberculated and rugose; those of the lateral line not much exceeding in depth the series below." (A. S. Woodward, *l. c.*, Pt. III, p. 431–2).

Thiollière's recognition of this species in the paleichthyic fauna of Cerin is stated to have been based upon two specimens showing the head, in which the rostrum projects considerably in advance of the anterior extremity of the mandible. A single specimen in the Carnegie Museum, catalogued as No. 4080, seems referable to this species, judging from the characters of the head, proportions of the anterior part of the trunk (which lacks the caudal region), and depth of the vertebral rings.

The small and incomplete fish, which is illustrated in the accompanying plate, possesses unusual interest on account of its containing within the abdominal cavity a well preserved skeleton of a small Rhynchocephalian reptile. The prey had been swallowed head first, and may have caused the death of the fish, as digestion had not proceeded far enough to dismember the limbs nor to disturb the natural position of the body-parts of the reptile, beyond a slight lateral compression of the trunk. The head, notwithstanding its small size, is very well preserved, a fact which is the more remarkable, when we consider the peculiar conditions which have revealed to us the fate of both creatures. In the case of the reptile, which is probably a young *Homœosaurus*, certain of the cranial elements and vacuities are distinguishable as well as the sensory canals and even a few minute teeth. So far as the writer is aware, paleontology affords no other instance of a fossil reptile enclosed within the digestive tract of a fish.

The apparent anomaly of finding a land reptile within the body of a marine fish may be accounted for by supposing the former to have been a shore-inhabitant of a coral island, thus resembling the modern *Sphenodon* in habitat. The creature may have been carried out to sea by floating vegetation, and been seized at a distance from land by a marine carnivorous fish. The proximity of land to the locality when the deposits at Cerin were laid down is indicated by a considerable quantity of plant remains, which have been described by Count G. de Saporta.

An exceedingly well preserved example, which has been chosen for the purpose of illustrating the characters of the adult of this species, is that shown in Plate LI, fig. 3, which belongs to the Museum of Comparative Zoology at Cambridge, Massachusetts.

Suborder *ISOSPONDYLI*.

"Notochord varying in persistence, the vertebral centra usually complete, but none coalesced; tail homocercal, but hæmal supports not much expanded or fused. Symplectic bone present; mandible simple, each ramus consisting only of two elements (dentary and articulo-angular), with rare rudiments of a splenial on the inner side. Pectoral arch suspended from the cranium; a precoracoid arch present, infraclavicular plates wanting; pectoral fin with not more than four or five basals. Pelvic fins abdominal. Scales ganoid only in the less specialized families." (A. S. Woodward, *l. c.*, Pt. III, p. 446).

Family PHOLIDOPHORIDÆ.

"Trunk elegantly fusiform. Head with delicate membrane-bones, the suborbital and circumorbital plates completely covering the cheek, all enamelled; snout

not produced; mandibular suspensorium nearly vertical or inclined forwards, and gape of mouth wide; premaxilla very small; maxilla large, loosely attached and with two well-developed supramaxillary plates; teeth small and conical. Opercular apparatus complete. Vertebral centra never advanced beyond the annular stage; ribs delicate; no fused nor expanded hæmal arches at the base of the tail. Intermuscular bones absent. Fin-fulcra present, but usually small; dorsal and anal fins small, the former above or behind the pelvic fins. Scales ganoid, more or less rhombic, but deeply overlapping, and the hinder margin often somewhat rounded." (A. S. Woodward, *l. c.*, Pt. III, p. 446–7).

Genus Pholidophorus Agassiz.

"Trunk not much deepened, and head relatively large. External bones smooth or delicately ornamented with rugæ and tuberculations; sensory canal on suborbital and preorbital plates branched; maxilla more or less arched, the oval margin convex and provided with minute teeth; mandibular teeth larger, but still minute and arranged in a single series. Preoperculum broad mesially and marked with slight radiating furrows; suboperculum large, but smaller than the trapezoidal operculum, from which it is divided by an oblique suture; branchiostegal rays numerous. Pleurocentra and hypocentra in notochordal sheath fused or separate. Fin-fulcra small, extending along the foremost ray of each of the fins. Pectoral not excessively large, but much exceeding the pelvic fins in size; dorsal and anal fins triangular in shape, not extended, the former opposite or arising somewhat behind the pelvic fins; caudal fin deeply forked. Scales thin, deeply overlapping, usually with an inner rib and peg-and-socket articulation, and the external layer of ganoine smooth or feebly ornamented; principal flank-scales deeper than broad, ventral scales in part broader than deep; no enlarged series of ridge-scales, but a large scale at the base of one or both lobes of the caudal fin, and three slightly enlarged scales round the anus at the base of the anal fin. Lateral line opening by widely separated large pores." (A. S. Woodward, *l. c.*, pp. 447–8).

The occurrence of this genus in the Lithographic Stone at Cerin was first reported by Thiollière, who recognized what he considered to be three new species, without, however, describing or naming them. Wagner, in 1860, recorded the presence of his newly described *P. ovatus* in the Cerin deposits, an identification concerning which later writers appear to have entertained some doubt. The only scientifically described species of this genus occurring at the Cerin locality is *P. similis*.

21. **Pholidophorus similis** A. S. Woodward. (Pl. LVI, fig. 1).

1895. *Pholidophorus similis* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 470, pl. XIII, fig. 2.

Type.—Nearly complete fish; British Museum.

A species attaining a length of about 20 cm. "Length of head with opercular apparatus nearly equalling the maximum depth of the trunk, which is contained from four-and-a-half to five times in the total length of the fish. Head and opercular bones very finely rugose. Fin-rays stout and smooth. Pelvic fins arising far in advance of the middle point of the trunk, and the dorsal fin opposed to them. Scales large, ornamented with fine oblique striations, more or less radiating, and terminating at the hinder margin in denticulations; several series of flank-scales deeper than broad; the orifices of the lateral line inconspicuous." (A. S. Woodward, *l. c.*, Pt. III, p. 470).

The undermentioned examples are representative of this species in the collections of the Carnegie Museum. Car. Mus. Cat., Nos. 4063, 4069, 4081, 4082, 4095, 4326, 4661, 4667.

22. **Pholidophorus ovatus** Wagner.

1863. *Pholidophorus ovatus* A. Wagner.

Abh. Bay. Akad., Wiss., math.-phys. Cl., Vol. IX, p. 666.

1895. *Pholidophorus ovatus* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 471.

"*Type.*—Fish with imperfect median fins; Paleontological Museum, Munich.

A robust species attaining a length of about 18 cm., not yet clearly distinguished from *P. granulatus*, but perhaps with a somewhat less deepened trunk. Fin-rays smooth and stout; fulcra conspicuous. Fins and scales as in the preceding species." (A. S. Woodward, *l. c.*, Pt. III, p. 471).

A single, moderate-sized, incompletely preserved example, cataloged as No. 4073, and probably referable to this species, is contained in the Bayet Collection.

Genus Pleuropholis Egerton.

"Trunk elongate-fusiform, and upper caudal lobe conspicuous. External bones smooth or delicately ornamented with rugæ and tuberculations; maxilla more or less arched and the oval margin convex; teeth minute. Vertebral centra annular. Fulcra present on all the fins. Pelvic fins well developed, but smaller than the pectorals; dorsal and anal fins longer than deep, opposite. Scales thick and moderately overlapping; those of the middle of the flank excessively deepened, covering nearly the whole of it, each strengthened within by a broad rib and exhibit-

ing a peg-and-socket articulation; dorsal and ventral scales few, relatively small and rhomboidal. Lateral line deflected, passing down the second or third deepened flank-scale and then traversing the uppermost series of small ventral scales." (A. S. Woodward, *l. c.*, Pt. III, p. 482–3).

23. **Pleuropholis thiollieri** Sauvage.

1873. *Pleurophoilis* V. Thiollière.

Poiss. Foss. Bugey, Pt. II, pl. VI, fig. 6.

1883. *Pleuropholis thiollieri* H. E. Sauvage.

Bull. Soc. Géol. France [3], Vol. XI, p. 499.

1895. *Pleuropholis thiollieri* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 485–6.

"*Type.*—Nearly complete fish; Lyons Museum.

A species attaining a length of about 12 cm. Length of head with opercular apparatus about equalling the maximum depth of the trunk and contained nearly five-and-a-half times in the total length of the fish; caudal pedicle slender, its width equalling two-thirds the depth of the flank-scales in the middle of the abdominal region. Pelvic fins arising midway between the pectorals and the anal; the latter fin arising slightly behind the middle point between the pectorals and the caudal. Scales smooth, not serrated." (A. S. Woodward, *l. c.*, Pt. III, pp, 485–6).

This species is represented in the collection by two individuals of average size, cataloged as Nos. 4318 and 4322. A smaller example, cataloged as No. 4032, is perhaps also referable to the same species. This latter is of about the same size as the unnamed original of Thiollière's Plate VI, fig. 5, a specimen which was subsequently described by Sauvage (Bull. Soc. Geol. France [3] Vol. XI, 1883, p. 498; pl. XIII, fig. 1) under the preoccupied title of *P. egertoni*. According to Dr. A. S. Woodward, the original of Thiollière's and Sauvage's illustrations is indistinguishable from *P. serrata* Egerton. In whatever way we may regard the identity of Thiollière's original (Poiss. Foss., Pt. II, 1873, pl. VI, fig. 5) the specimen bearing the Carnegie Museum Catalog Number 4032 differs from it in the non-serrated condition of the principal flank-scales.

Family OLIGOPLEURIDÆ.

"Trunk fusiform. Head with delicate membrane bones, scarcely, if at all, enamelled; mandibular suspensorium nearly vertical or inclined forwards, and gape of mouth wide; teeth small or of moderate size. Vertebral centra well-ossified, with no distinct pleurocentra and hypocentra in any part of the column; large free

neural spines in the abdominal region; ribs short; no fused or expanded hæmal arches at the base of the tail. Intermuscular bones rare or absent. Fin-fulcra present; dorsal and anal fins acuminate in front, of variable length. Scales thin, more or less rounded, and deeply imbricating." (A. S. Woodward, *l. c.*, Pt. III, p. 490).

Genus Œonoscopus Costa.

(Syn. *Attakeopsis* V. Thiollière; *Macrorhipis* A. Wagner.)

"Head large and snout pointed; maxilla much deepened behind, with nearly straight dentigerous border; teeth of moderate size, stout and conical or styliform. Vertebral centra usually about as long as deep, and the side of each exhibiting a median longitudinal ridge with a deep pit above and below; ribs robust, but short. Fin-rays robust, all closely articulated and divided at some distance from the base; fulcra conspicuous on the median fins. Dorsal and anal fins short-based, the former almost or completely in advance of the latter; caudal fin much forked. Scales large." (A. S. Woodward, *l. c.*, Pt. III, pp. 494–5).

24. **Œonoscopus desori** (Thiollière).

1858. *Attakeopsis desori* Thiollière.
Bull. Soc. Géol. France [2] Vol. XV, p. 784 (name only).
1873. *Attakeopsis desori* Thiollière.
Poiss. Foss. Bugey, Pt. II, p. 23, pl. XI.
1887. *Œonoscopus desori* K. A. von Zittel.
Handb. Paleont., Vol. III, p. 232.
1895. *Œonoscopus desori* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 497.

Type.—Nearly complete fish; Lyons Museum.

This species, regarded by Thiollière as the type of a distinct genus, named by him *Attakeopsis*, is of moderate size, attaining a length of about 35 cm. Length of head with opercular apparatus nearly equal to the maximum depth of the trunk and contained somewhat more than four times in the total length of the fish; cauda pedicle less than half as deep as the abdominal region. Teeth closely arranged in the maxilla and dentary. Vertebræ not more than 50 in number and mostly as long as deep. Pelvic fins arising at a point about midway between the pectorals and anal fin; median fins as in *O. cyprinoides*.

An excellent figure of an example of this species, without description, is given in the posthumous work of Thiollière, published in 1873. A single specimen is recorded in Dr. Woodward's Catalogue as belonging to the British Museum. Two

representatives of this species are contained in the collections of the Carnegie Museum, one having a length of 17 cm. and the other of 28 cm. These bear the catalog numbers 4303 and 4432 respectively. The former of these displays the undigested remains of a small vertebrate, probably a lizard-like reptile, within the abdominal cavity. Either the vertebral column of the enclosed prey has been flexed upon itself, or there are two small creatures to be seen within the body of the fish.

25. **Œonoscopus elongatus** Eastman. (Plate LVI, figs. 2 and 3).

1912. *Œonoscopus elongatus* C. R. Eastman.

Ann. Carnegie Mus., Vol. VIII, p. 185, pl. XI.

Type.—Nearly complete fish in counterpart: Carnegie Museum Catalogue No. 4079+4079*a*.

A small-sized species, attaining a length of about 20 cm. and distinguished from all others belonging to the same genus by its slender and elongated form of body, and by the more forward position of the dorsal fin, which arises opposite the pelvics, and does not extend back of a point midway between them and the origin of the anal. Length of the head with opercular apparatus exceeding the maximum depth of trunk, and contained about five times in the total length of the fish. Vertebræ about 50 in number, with strong neural and hæmal spines. A single large ridge-scale at the upper and lower borders of the caudal pedicle. Teeth small and conical. All fins relatively small, caudal lobes not much expanded.

The holotype of this species is a nearly complete fish preserved in counterpart, cataloged as No. 4079+4079*a*. It has a total length of 19 cm., and is interesting for containing apparently a small Rhynchocephalian reptile within the abdominal cavity. Another example, cataloged as No. 4088, is about one-third smaller than the type and is complete except for the anterior margin of the head, which is wanting. Three small specimens of *Leptolepis* are preserved in the same slab, one either superimposed over the body of the large fish in a longitudinal direction, or contained inside.

Family LEPTOLEPIDÆ.

"Trunk elegantly fusiform. Head with delicate membrane-bones, the suborbital and circumorbital plates almost or completely covering the cheek, more or less enamelled; parietal bones meeting in the middle line; snout not produced; mandibular suspensorium nearly vertical or inclined forwards, but gape of mouth wide; premaxilla very small; maxilla large, loosely attached and with two well-developed supramaxillary plates; teeth small and conical. Opercular apparatus complete. Vertebral centra well ossified, but always pierced by the notochord; ribs delicate;

no fused or expanded hæmal arches at the base of the tail. Intermuscular bones present. Fin-fulcra absent; fin-rays more or less divided and articulated distally; dorsal and anal fins small, the former usually short-based, above or behind the pelvic pair. Scales thin, cycloidal and deeply imbricating, usually ganoid in their exposed portion; lateral line not observable." (A. S. Woodward, *l. c.*, Pt. III, p. 500).

Genus Leptolepis Agassiz.

"Head large and teeth minute; sclerotic ossified. Maxilla arched, with a slightly convex dentigerous border; mandible prominent, and dentary sharply rising into a thickened, obtuse elevation near its anterior extremity; preoperculum broad mesially, with a large inferior limb, marked with radiating ridges; subopercular large, but smaller than the trapezoidal operculum, from which it is divided by an oblique suture. Vertebræ in the form of much-constricted cylinders, with little or no secondary ossification. Pelvic fins relatively large; dorsal fin about as long as deep, opposed to the pelvic pair or to the space between the latter and the anal; anal fin small, not much extended; caudal fin deeply forked. Scales completely covering the trunk; no enlarged or thickened ridge-scales." (A. S. Woodward. *l. c.*, P. III, p. 501).

26. **Leptolepis sprattiformis** (Blainville).

1755. Figure by G. W. Knorr.
Samml. Merkwürdigk. Natur, pl. XXIII, figs. 2, 3; pl. XXVIII, fig. 3; pl. XXIX, figs. 2–4.

1818. *Clupea sprattiformis* H. D. de Blainville.
Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 330.

(?) 1839. *Leptolepis pusillus* G. von Münster.
Neues Jahrb., p. 680.

1833–44. *Leptolepis sprattiformis* L. Agassiz.
Poiss. Foss., Vol. II, Pt. I, p. 13; Pt. II, pp. 130, 294, pl. LXI*a*, fig. 1.

1839–44. *Leptolepis macrolepidotus* L. Agassiz.
Ibid., Pt. II, p. 132, pl. LXI, figs. 4–6.

1863. *Leptolepis sprattiformis* A. Wagner.
Abh. K. Bay. Akad. Wiss., Math.-Phys., Cl., Vol. IX, pp. 741, 744.

1888. *Leptolepis sprattiformis* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 272, fig. 279.

1895. *Leptolepis sprattiformis* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 513.

Type.—Nearly complete fish; Museum of Natural History, Paris.

The occurrence of this species in the Lithographic Stone of Cerin, France, is reported by Thiollière in the faunal list included in his posthumous work of 1873. A considerable number of small and indistinct impressions which may be referred to this species, or may be the fry of some other Leptolepid, are contained in the Bayet Collection. A slab in which several are to be seen has already been spoken of in connection with a specimen of *Œonoscopus elongatus* (No. 4088), which apparently contains one of the small fry inside.

27. **Leptolepis dubia** (Blainville). (Plate LI, Fig. 1).

1818. *Clupea dubia* H. D. de Blainville.

Nouv. Dict. d'Hist. Nat., Vol. XXVII, p. 331.

1833–44. *Leptolepis dubius* L. Agassiz.

Poiss. Foss., Vol. II, Pt. I, p. 13; Pt. II, pp. 134, 294 (in part).

1895. *Leptolepis dubius* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 509, pl. XIV, figs. 6, 7.

Type.—Nearly complete fish; Museum of Natural History, Paris.

This is a large and robust species, attaining a length of about 30 cm., and very abundant in the Lithographic Stone of Bavaria. It has not hitherto been reported from other localities than in the neighborhood of Solenhofen and Eichstädt, but there is one example in the Bayet Collection of the Carnegie Museum which is evidently referable to this species, and is figured in the accompanying plates. It is from the Upper Jura of Cerin, France, and, together with the smaller species of the same genus, serves to illustrate the close correspondence existing between the faunæ of the respective localities. The figured specimen is cataloged as No. 4396.

Genus Thrissops Agassiz.

"Head small and teeth minute; sclerotic ossified. Maxilla arched, with a slightly convex dentigerous border; mandible prominent, the dentary apparently intermediate in form between that of *Leptolepis* and *Æthalion*. Opercular apparatus as in *Leptolepis*. Vertebral centra well ossified, strengthened by a median lateral ridge; the free neural arches in the abdominal region much elongated and thickened, the ribs also especially robust. Pelvic fins much smaller than the pectorals; dorsal fin small and short-based, opposite to the anal fin, which is acuminate in front, and much extended behind; caudal fin forked. Scales completely covering the trunk; no enlarged or thickened ridge-scales." (A. S. Woodward, *l. c.*, Pt. III, p. 521).

28. **Thrissops formosus** Agassiz.

1833–44. *Thrissops formosus* L. Agassiz.
Poiss. Foss., Vol. II, pt. I, p. 12; Pt. II, p. 124, pl. LXV*a*.
1844. *Thrissops subovatus* L. Agassiz (*ex* Münster MS.).
Ibid., Pt. II, p. 128 (undefined).
1839. *Thrissops ovatus* G. von Münster.
Neues Jahrb., p. 680.
1852. *Thrissops formosus* F. A. Quenstedt.
Handb. Petrefakt., p. 219, pl. XVII, fig. 19.
1863. *Thrissops formosus* A. Wagner.
Abh. K. Bayer. Akad. Wiss., Math.-Phys. Cl., Vol. IX, p. 734.
1863. *Thrissops subovatus* A. Wagner.
Ibid., p. 734.
1888. *Thrissops formosus* K. A. von Zittel.
Handb. Paläont., Vol. III, p. 273, figs. 280, 281.
1895. *Thrissops formosus* A. S. Woodward.
Cat. Foss. Fishes Brit. Mus., Pt. III, p. 521.

"*Type.*—Nearly complete fish; Paleontological Museum, Munich.

The type-species, attaining a length of about 50 cm. Head with opercular apparatus occupying from one-eighth to one-seventh of the total length of the fish; maximum depth of trunk much exceeding the length of the head with opercular apparatus, and contained about three-and-a-half times in the length of the trunk from the pectoral arch to the base of the caudal fin. Vertebræ at least 60 in number, about 32 being abdominal and 28 caudal. Pelvic fins arising much nearer to the anal than to the pectorals, and comprising about 5 rays; dorsal fin with 14 rays, arising somewhat behind the origin of the anal, which is much elevated in front and comprises not less than 30 rays; caudal fin very deeply forked and the lobes slender. Scales partly ornamented with delicate radiating striæ." (A. S. Woodward, *l. c.*, Pt. III, p. 521).

A single undoubted representative of this species, which has not been heretofore reported from the French lithographic limestone, forms part of the Bayet Collection in the Carnegie Museum, and is cataloged as No. 4083. It has a total length of about 34 cm., the extremity of the tail being preserved in impression.

29. **Thrissops regleyi** Thiollière.

1854. *Thrissops regleyi* Thiollière.
Poiss. Foss. Bugey, Pt. I, pl. X, fig. 2 (figure only).

1861. *Thrissops clupeoides* Winkler.

Natuurk. Verhandl. Holland. Maatsch. [2] Vol. XIV, p. 21, fig. 3.

1895. *Thrissops clupeoides* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 523.

Type.—Nearly complete fish; Lyons Museum.

A species attaining a length of about 25 cm. Head with opercular apparatus contained about four times in the total length exclusive of the caudal fin, and equalling the maximum depth of the trunk. Vertebræ about 50 in number, of which 25 are caudal. Fins as in the type-species, except that the caudal is much less deeply forked and with broader lobes. Lower limb of the preoperculum ornamented with about ten fine radiating elevated ridges.

30. **Thrissops heckeli** Thiollière.

1854. *Thrissops heckeli* Thiollière.

Poiss. Foss. Bugey, Pt. I, pl. X, fig. 1 (no description).

1895. *Thrissops heckeli* A. S. Woodward.

Cat. Foss. Fishes Brit. Mus., Pt. III, p. 527.

Type.—Contorted large fish; Lyons Museum.

The holotype of this undescribed species is a large specimen having a total length of about 73 cm. It is slender and elongate in form, the proportions resembling those of *T. formosus*, but the pectoral and caudal fins are much more strongly developed than in that species, and the lobes of the tail are narrower and longer.

A single specimen in the collection of the Carnegie Museum, cataloged as No. 4091, is apparently referable to this species. It shows the head-region with the opercular apparatus, together with the powerful pectoral fin of the left-hand side, in which thirteen extremely stout rays are to be counted, decreasing in length gradually in a posterior direction.

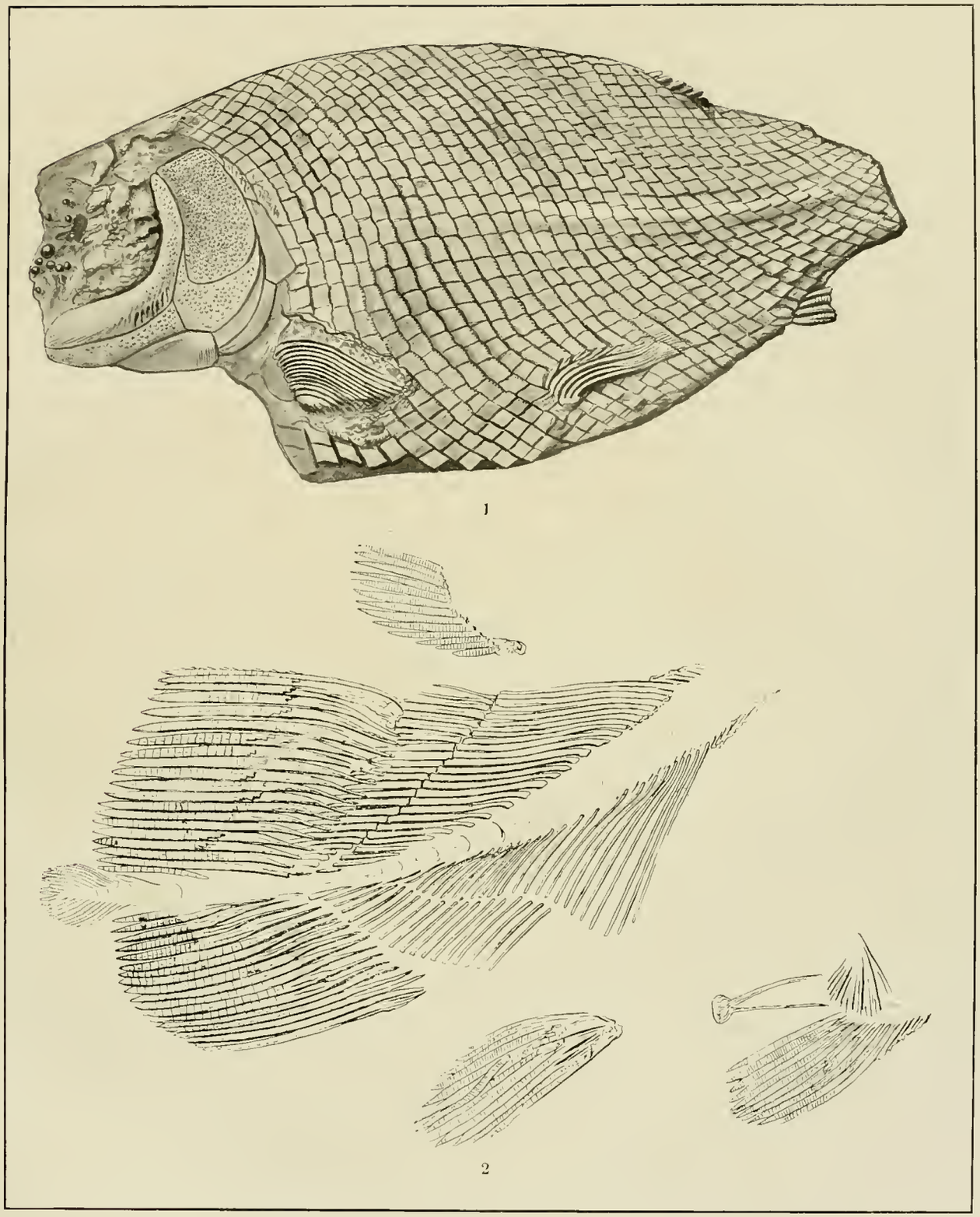
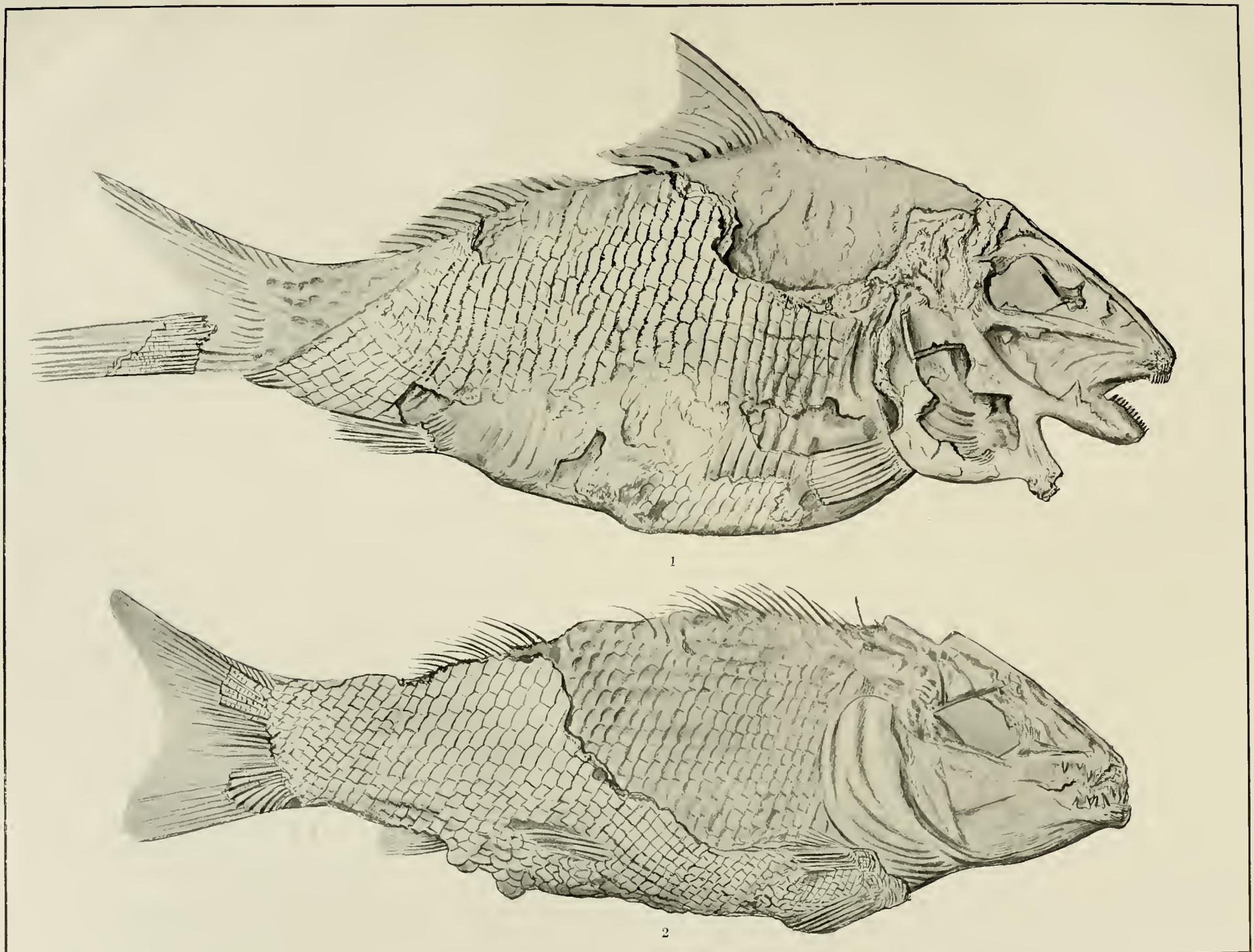


FIG. 1. *Lepidotus lævis* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 5130. $\times \frac{1}{3}$.
FIG. 2. *Undina grandis* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4748. $\times \frac{1}{3}$.



1

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FIG. 1. *Histionotus falsani* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4077. $\times \frac{3}{2}$.
FIG. 2. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4660a. $\times \frac{3}{2}$.

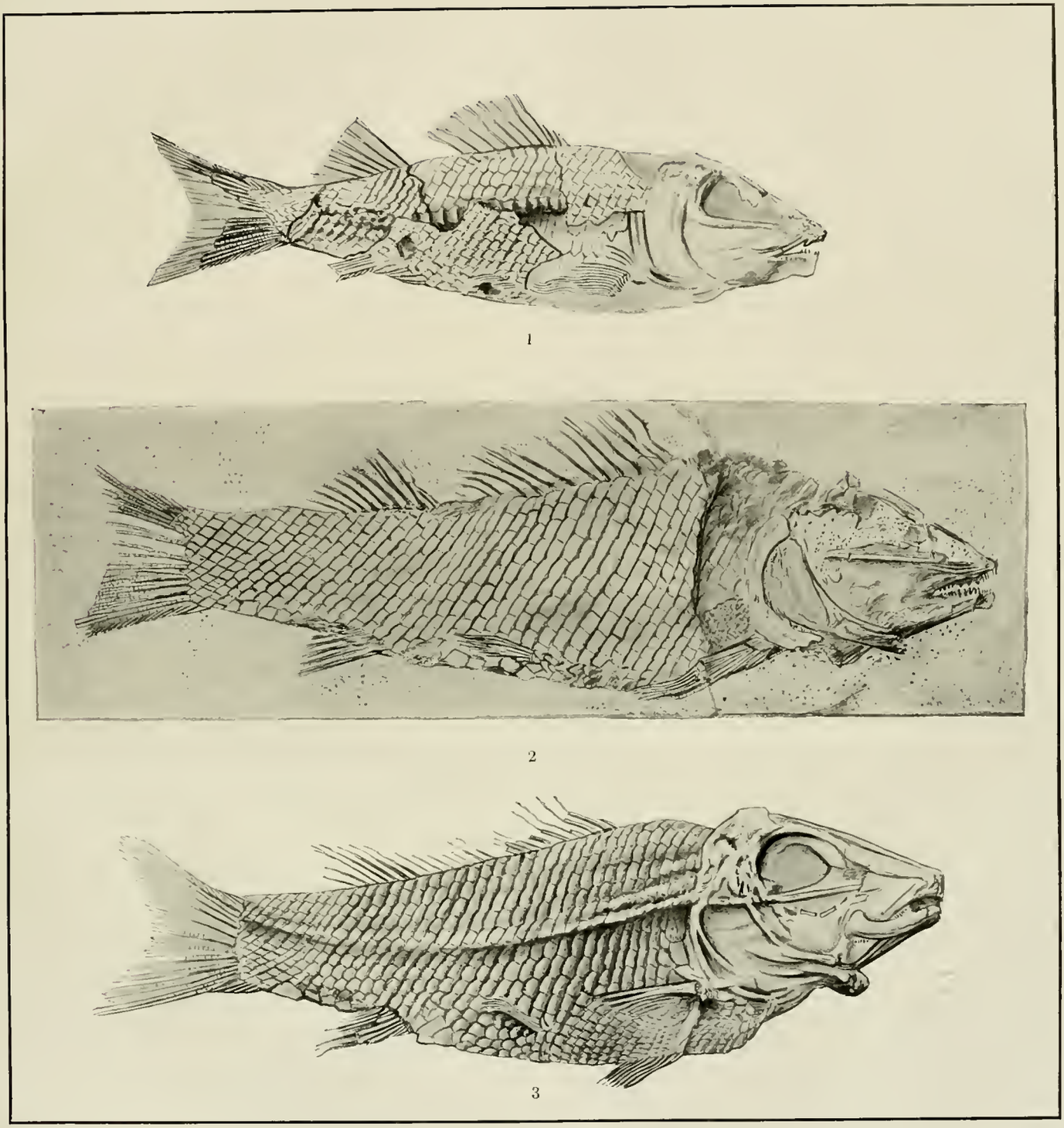

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FIG. 1. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 5115. $\times \frac{3}{2}$.
FIG. 2. *Notagogus inimontis* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, No. 4399. $\times \frac{3}{2}$.
FIG. 3. *Notagogus ornatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5114a. $\times \frac{3}{2}$.

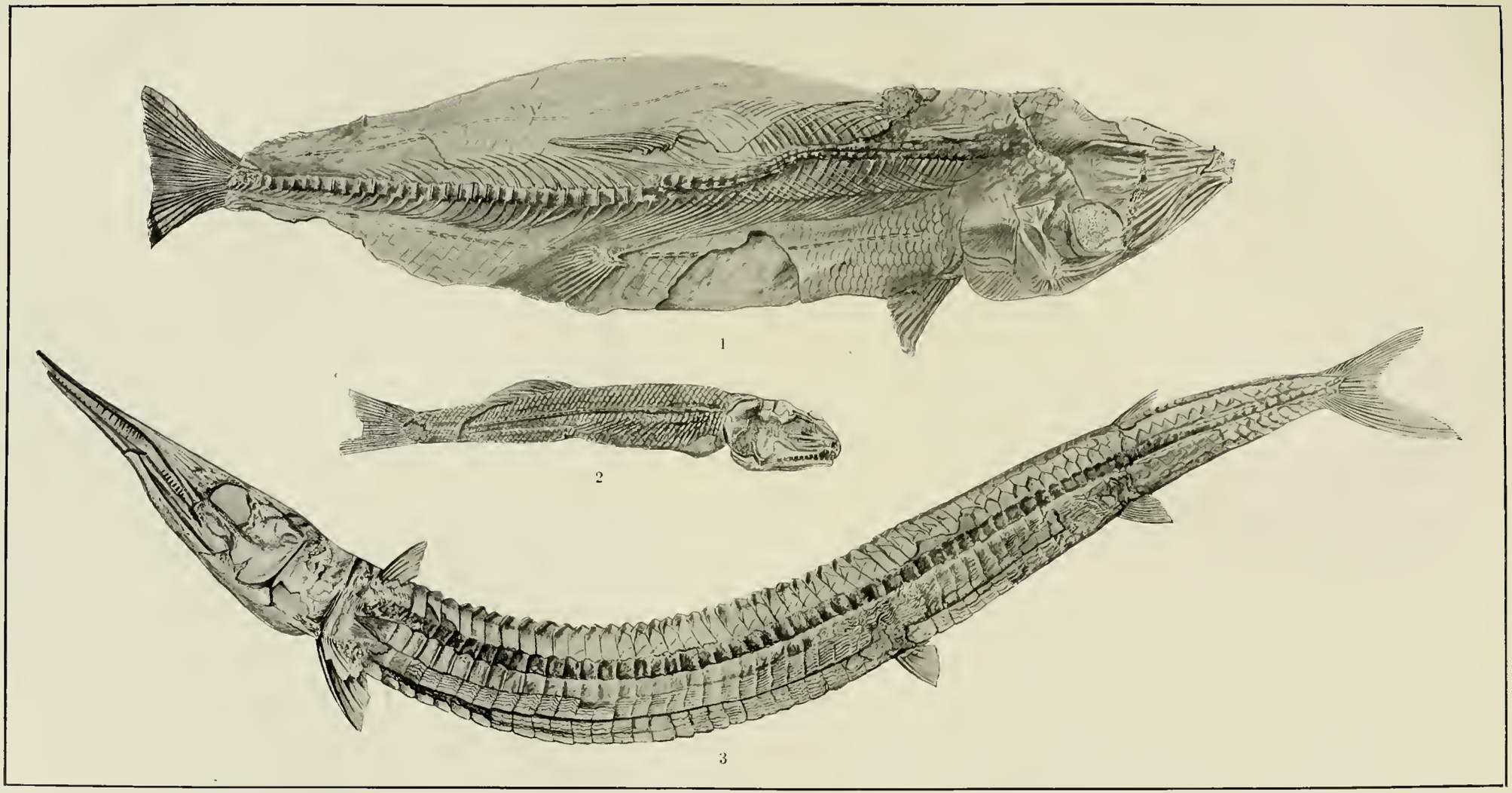

FIG. 1. *Leptolepis dubia* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4396. $\times \frac{1}{1}$.
FIG. 2. *Ophiopsis macrodus* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, NO. 4104. $\times \frac{1}{1}$ CIRCA.
FIG. 3. *Belenostomus tenuirostris* AGASSIZ. MUS. COMP. ZOÖL., HARVARD UNIV. $\times \frac{1}{1}$ CIRCA.

FIG. 1. *Microdon bernardi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 4084. $\times \frac{64}{100}$.
FIG. 2. *Microdon bernardi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 5118. $\times \frac{4}{5}$.

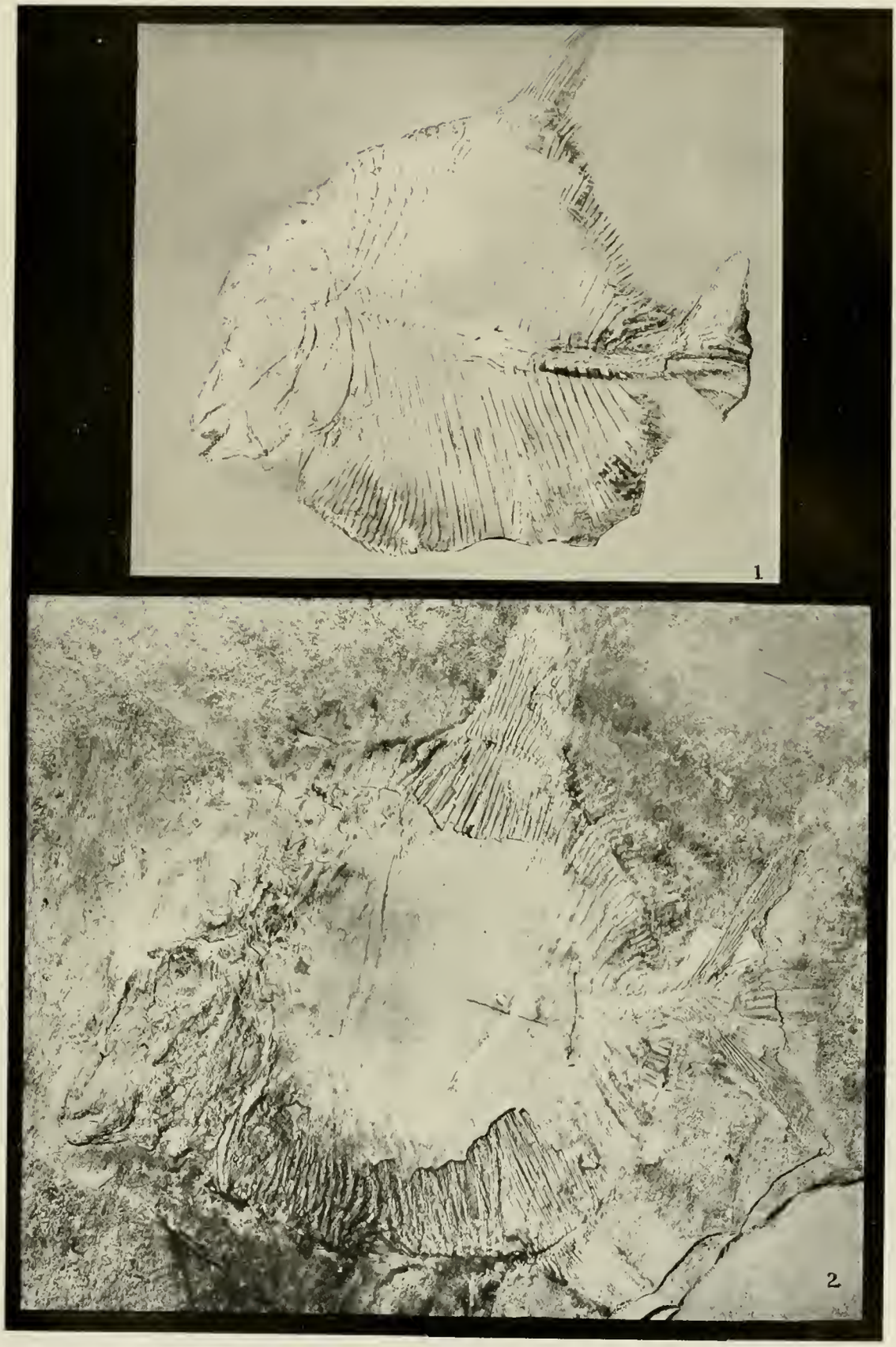

FIG. 1. *Microdon Wagneri* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 4090. $\times \frac{3}{4}$.
FIG. 2. *Microdon Wagneri* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 4320. $\times \frac{1}{2}$.

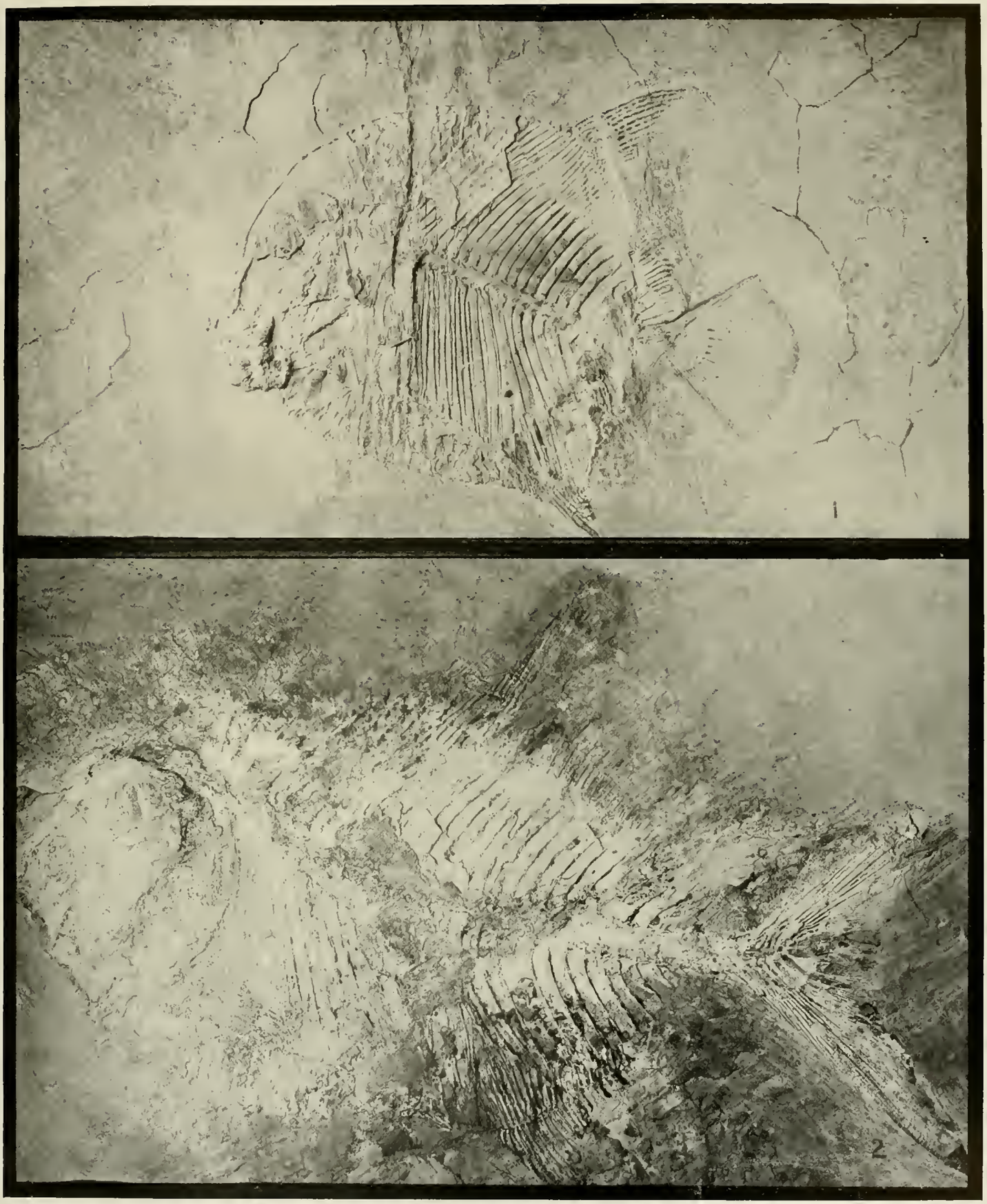

FIG. 1. *Microdon egertoni* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 5107. $\times \frac{4}{5}$.
FIG. 2. *Microdon sauvanausi* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, No. 4666. $\times \frac{53}{100}$.

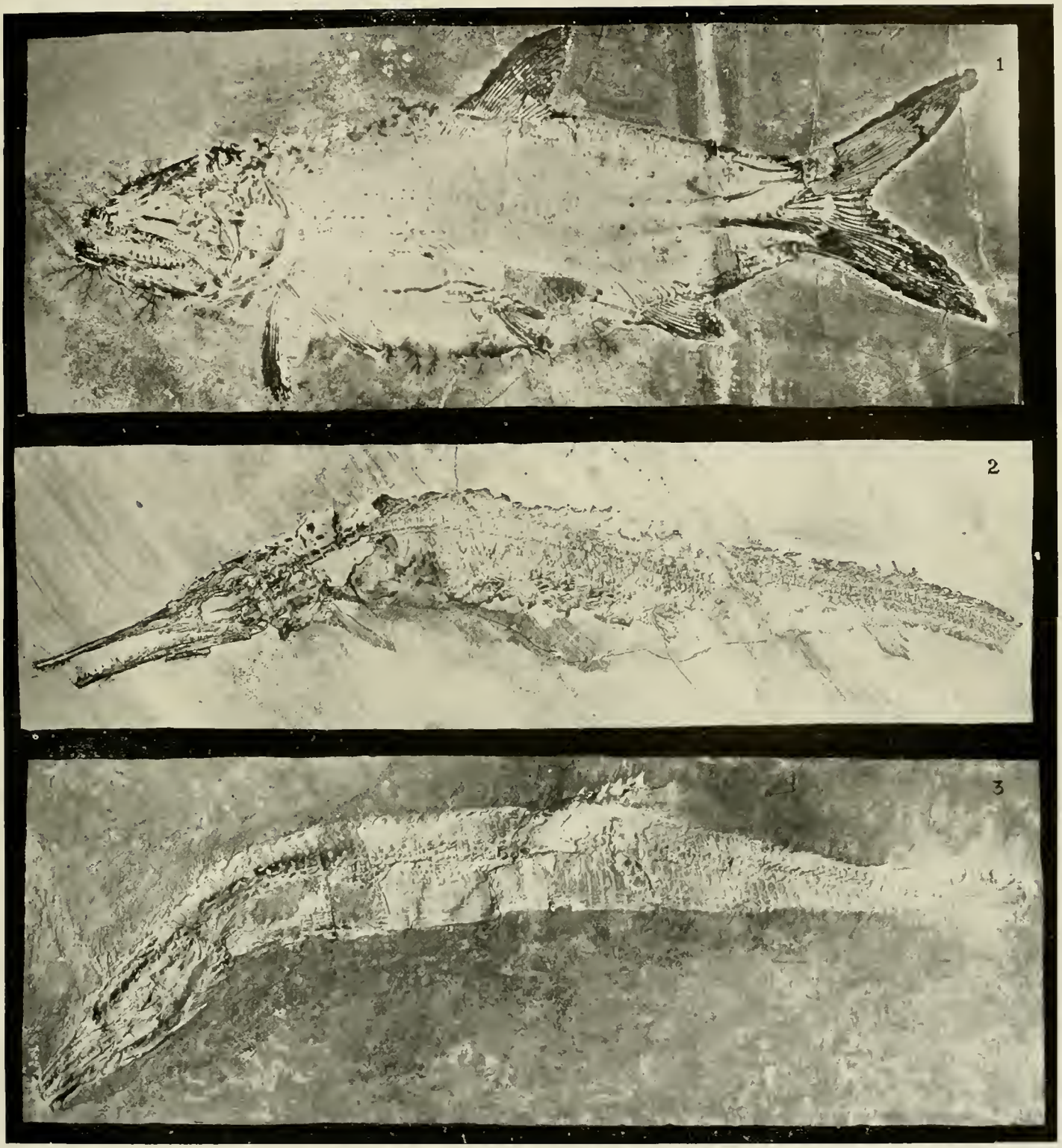

FIG. 1. *Caturus furcatus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4301. $\times \frac{4}{5}$.
FIG. 2. *Belenostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4343. $\times \frac{3}{4}$.
FIG. 3. *Belenostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 5112. $\times \frac{5}{6}$.

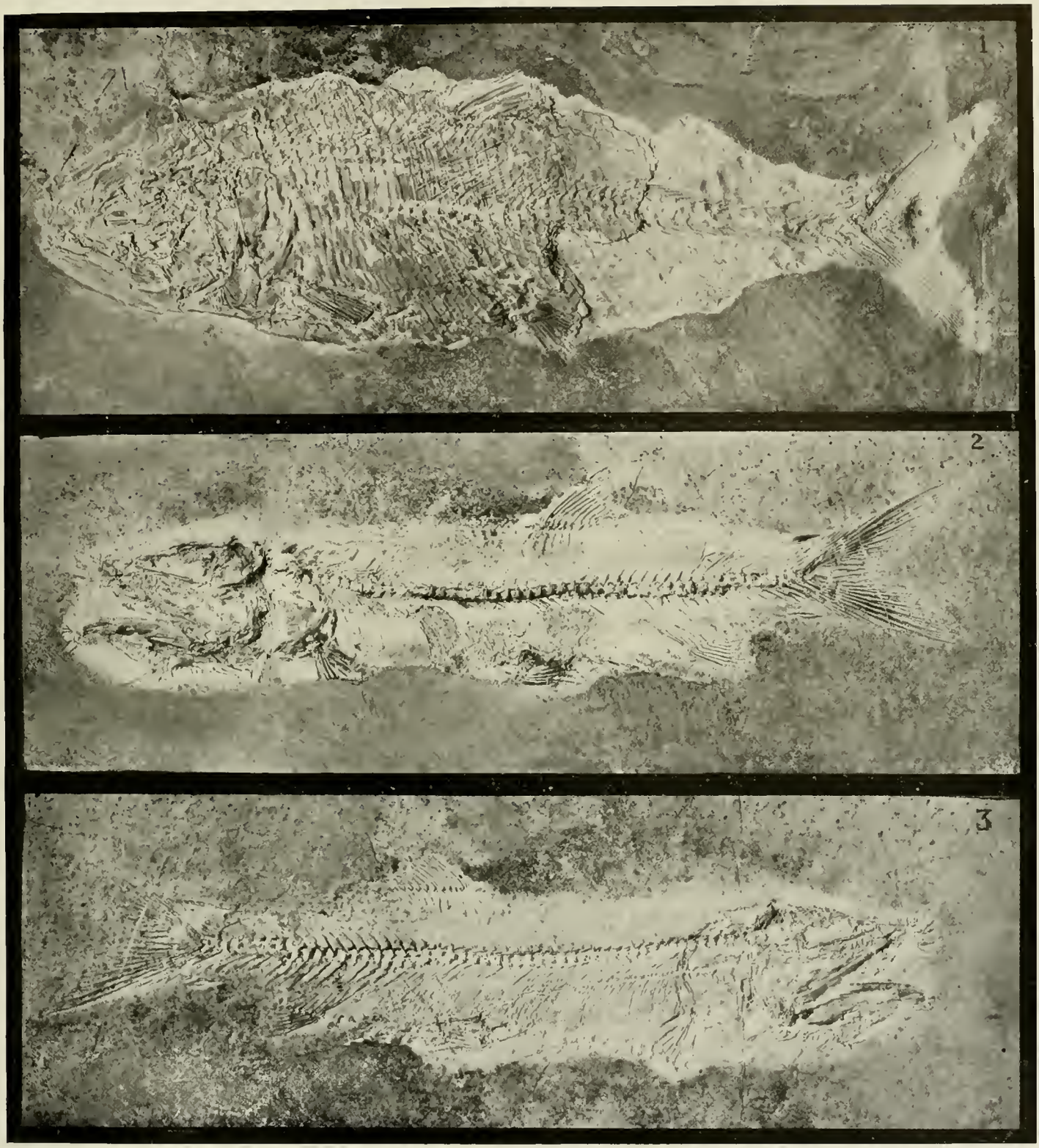

FIG. 1. *Pholidophorus similis* A. S. WOODWARD. C. M. CAT. FOSS. FISHES, No. 4081. × $\frac{7}{8}$.
FIG. 2. *Œonoscopus elongatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4079. × $\frac{7}{8}$.
FIG. 3. *Œonoscopus elongatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4079a. × $\frac{7}{8}$.

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MEMOIRS

OF THE

CARNEGIE MUSEUM.

VOL. VI. NO. 7.

W. J. HOLLAND, EDITOR.

CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM

PART IV. DESCRIPTIVE CATALOG OF FOSSIL FISHES FROM THE LITHOGRAPHIC STONE OF SOLENHOFEN, BAVARIA

By C. R. EASTMAN.

PITTSBURGH.

PUBLISHED BY THE AUTHORITY OF THE BOARD OF TRUSTEES OF THE

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MEMOIRS

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CARNEGIE MUSEUM.

Vol. VI. No. 7.

CATALOG OF THE FOSSIL FISHES IN THE CARNEGIE MUSEUM.

By C. R. Eastman.

Part IV. Descriptive Catalog of Fossil Fishes from the Lithographic Stone of Solenhofen, Bavaria.*

(Plates LVII–LXXIII.)

The present paper deals with the fossil fishes from Solenhofen, and is principally based upon the fine collection of these acquired through the generosity of Mr. Andrew Carnegie in 1903, when the paleontological treasures amassed by Baron Bayet were purchased for the Museum. The Bayet Collection, by far the largest and most important assemblage of Mesozoic fishes from European localities to be found in any institution on this side of the Atlantic, compares favorably with many of the best known European collections from the same locality. A splendid suite of specimens illustrating the ichthyic and reptilian fauna of the Solenhofen deposits is to be seen on exhibition in the Hall of Fossil Vertebrates, where it constitutes an imposing display.

* In July, 1913, Dr. C. R. Eastman submitted to the Director a manuscript upon the Fossil Fishes from Solenhofen contained in the Carnegie Museum. For reasons, which it is not necessary here to state, various delays occurred in the preparation of the manuscript for publication and of the plates which accompany it. The present paper cannot be accepted as a perfect catalog of the fossil fishes from Solenhofen contained in the Carnegie Museum, but because it embodies some valuable information and tends to throw new light upon the subject the Editor gives it to the public. *W. J. Holland.*

It must be regarded as an exceedingly fortunate circumstance for paleontology that calcareous deposits of the kind known as Lithographic Stone should occur in the Upper Jurassic rocks of various parts of Europe, more especially in northern Bavaria and in the Department of Ain, France, because of the excellence of preservation in this medium of the most delicate structures and impressions.

Laid down in the shallow lagoons of coral atolls in the form of fine calcareous ooze, the material itself, and the conditions under which it was deposited, lent themselves to the registration with extreme fidelity of the structural features of the organisms which were imbedded in it. In consequence it not infrequently happens in the case of the fishes that we are acquainted not only with the entire skeletal anatomy and the minute details of the hard parts, but even with soft tissues, such as the muscular fibres, the air-bladder, the intestinal tract, the fin-membranes, and in a few rare instances with the egg-capsules of cartilaginous forms. The favorable circumstances of preservation, to which these structures and others equally delicate, such as the plumage of *Archæopteryx* and impressions of *Medusæ* bear witness, have enabled us to study fossil organisms embedded in hard rock with a degree of minuteness, which is scarcely possible elsewhere throughout the stratigraphic column.

A few words as to the general character of the ichthyic fauna of Solenhofen may be appropriate. It is chiefly composed, as is the universal rule in strata of Mesozoic age, of "ganoids," that is, of teleostomous fishes belonging to both the Crossopterygian and Actinopterygian orders. A number of interesting survivals of archaic types are to be observed, not the least remarkable among which belong to the group of primitive sturgeons, *Chondrostei*, and to the characteristically Mesozoic suborder known as *Protospondyli*. Examples are furnished under either head by the genera *Coccolepis* and *Homœolepis* which are the terminal members of the long-lived series to which they respectively belong, the *Palæoniscidæ* and *Semionotidæ*. *Undina* presents another illustration.

The Dipnoan subclass, which formed so important an element of the Paleozoic vertebrate fauna, is without known representatives in the strata under consideration, or indeed anywhere in the Jurassic, the group having declined markedly in the Trias, although its more generalized members continued to survive until modern times.

Coincident with the decline of Paleozoic lung-fishes is to be noted the almost total extinction of Elasmobranchs toward the close of the older era, in which they had been especially prolific. Nevertheless fragmentary remains of this class are recognizable in rocks of Triassic age, and entire skeletons of undoubted Selachians

(*Palæospinax*) are known first from the Lower Lias. These latter have completed vertebral centra, and the Upper Jura furnishes examples of well-formed vertebræ of the types characteristic of modern sharks and rays, that is to say, truly asterospondylic and tectospondylic vertebral centra. Students of the group are well aware that, as was first demonstrated by Prof. Carl Haase, the time-honored division of Selachii into sharks and rays corresponds very closely to constant differences displayed by the structure of the vertebral bodies. In the rays, or *Tectospondyli*, a series of concentric lamellæ surrounds the primitive double cone of each vertebral centrum; in the majority of sharks (*Asterospondyli*) the centra, when fully developed, are strengthened by longitudinal ridges or radiating laminæ, which, when viewed in transverse section, present a stellate appearance.

Typical representatives, therefore, of the suborders embracing modern sharks are met with in the fauna of the Lithographic Stone of Bavaria. Nearly complete examples are known of a shark resembling the recent Cestracion (*Heterodontus*), and the same is true of certain dog-fishes, *Scyllium* and *Pristiurus*, while beautifully preserved skeletons of *Squatina* and *Rhinobatus*, scarcely to be distinguished from their modern successors, occur in the same horizon. Turning our attention finally to the order or sub-class of Holocephali, this is represented in the fauna under discussion by two genera, *Chimæropsis* and *Ischyodus*. The collections of the Carnegie Museum do not contain examples of either of the two last-named genera, but the deficiency is more than compensated by a number of splendidly preserved rays, including a magnificent *Rhinobatus* from Eichstädt, the counterpart of which is figured in von Zittel's "Handbuch der Paläontologie," Vol. III, p. 102.

An inspection of the subjoined classificatory scheme will permit the major divisions of the class Pisces, which enter into the constitution of the fauna of the Lithographic Stone, to be recognized at a glance.

Class PISCES.

Subclass.	Order.	Suborder.
Elasmobranchii	(*Pleuropterygii*)	Not represented.
	(*Ichthyotomi.*)	"
	(*Acanthodei.*)	"
	Plagiostomi	*Selachii.*
		Batoidei.
	Holocephali	*Chimæroidei.*

Subclass.	Order.	Suborder.
Teleostomi	*Crossopterygii*	*Actinistia.*
	Chondrostei.	
	Holostei.	
	Teleostei.	

After these brief introductory remarks we pass on to the enumeration of the genera and species of the fishes from Solenhofen which are represented in the collections of the Carnegie Museum.

CLASS PISCES.

Sub-Class I. ELASMOBRANCHII.

"The Elasmobranchs are certainly a very primitive race of Fishes. Their earliest representatives of whose structure we have any precise knowledge (*e. g.*, *Cladoselache* and *Pleuracanthus*) are in many respects the most archaic of known gnathostomatous Craniates, and from such types as these, among others, we may very reasonably look for the ancestors of all or most of the remaining groups of Fishes. It has been well said of *Pleuracanthus* that 'it is a form of Fish which might with little modification become either a Selachian, Dipnoan, or Crossopterygian,'[1] while the condition of the primary upper jaw in the Chondrostean *Polyodon* suggests that even the more primitive Actinopterygii had an Elasmobranch origin." (Cambridge Natural History, Fishes, pp. 435–6.)

We here follow the arrangement adopted by Professor T. W. Bridge in the Cambridge Natural History, grouping the Selachians and Batoidei under the ordinal term of Plagiostomi. It should be borne in mind, however, that authorities are not agreed as to the propriety of maintaining these subdivisions in the ordinary manner, that is, classifying as sharks those cartilaginous fishes which have lateral gill-clefts, and as rays those with ventral gill-clefts. More or less constant differences exist with regard to the manner of specialization of the vertebral centra, as indicated by the terms asterospondylic and tectospondylic, and it is further recognized that modern sharks and rays form two approximately natural groups, the former tending towards agility in swimming, the latter towards expertness in feeding on the bottom. Although a few existing sharks have become adapted for life on the sea-bottom and have a depressed form of body, nevertheless they do not have the enlarged pectoral fins which belong to the rays, and the anal fin in no case disappears, as it does in the latter.

[1] Smith Woodward, Vert. Palæont., 1898, p. 32.

Order PLAGIOSTOMI.

Suborder *SELACHII.*

Family CESTRACIONTIDÆ.

Genus Cestracion Cuvier.

"To this existing genus, commonly known as the Port Jackson shark, have been referred certain skeletal remains, not as yet satisfactorily distinguished from it, which occur in the Lithographic Stone of Bavaria. The type-specimen, upon which the so-called '*Acrodus falcifer*' Wagner (= *Cestracion*) was founded, is preserved in the Paleontological Museum at Munich, and other imperfect portions of the skeleton are to be seen in the British Museum. None, however, exhibits the entire outline and fin-characters at all satisfactorily."[2]

1. Cestracion falcifer Wagner.

(For references to the literature prior to 1911 *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 332.)

1911. *Cestracion falcifer* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 400.

"The typical example of this species shows every indication of being an adult individual and is estimated to have had a total length of about 40 cm. In it the two dorsal fin-spines are seen to be of unequal size, both are slightly recurved, and that of the anterior dorsal is inserted at a point about midway between the origin of the pectorals and posterior dorsal fin. It would appear from the published figures, also, that the pelvic pair arises opposite the first dorsal; and the shagreen granules are described as 'schaufelförmige oder körnelige,' without being markedly differentiated in size.

"To this species has been referred by von Zittel (*loc. cit.*, p. 77) a well preserved smaller individual, the total length of which is only 12.5 cm., or less than one-third of that of the type. According to the same author this smaller specimen, which he regards as the young of *C. falcifer,* has feebly striated lateral teeth, and is provided with enlarged stellate tubercles in the dorsal region. The description of this feature reads: 'Neben den schaufelförmig gestalteten Chagrinschuppen liegen in der Rückenregion kurze gekrümmte Stacheln, welche sich auf einer vierstrahligen Basis erheben.'

"It cannot escape notice that the smaller example just referred to presents characters in common with the well-preserved specimen in the Carnegie Museum from the same horizon and locality, immediately to be described as the type of a

[2] Eastman, C. R., Am. Jour. Sci. (4), Vol. XXXI, p. 400.

new species, and it seems proper to associate under the latter head the small shark, which von Zittel regarded as the young of *C. falcifer.*"[3]

2. Cestracion zitteli Eastman. (Plate LVII, fig. 1.)

1911. *Cestracion zitteli* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 401, pl. I.

Type.—Nearly complete skeleton; Carnegie Museum (Cat. No. 4423).

"The example, which is here regarded as typifying a distinct species, merits special attention on account of its being probably the most perfect post-Liassic Cestraciont shark, which has thus far been discovered in the fossil state. Agreeing in principal characteristics with the small form described by von Zittel as the young of *C. falcifer,* as above stated, its features are nevertheless judged to be sufficiently distinctive to warrant a separation from that species.

"The more important differences relate to the position of the dorsal fins, form and relative size of the dorsal fin-spines, number and size of the vertebral centra, and presence of a series of enlarged, radially ridged, and acutely conical shagreen tubercles along the back. A comparison of characters displayed by the dentition in the type-specimen is impossible, as the teeth are unfortunately not preserved, but in the small Munich example, which may be with entire propriety associated with the type now under description, the lateral teeth are said to be 'mit einer Anzahl von Zacken versehen.' This may be understood to mean that the oral surface is faintly rugose, transversely striated perhaps, or else that the coronal margin is slightly indented. In any case, however, the teeth must have been exceedingly minute.

"A summary of the chief features of interest presented by the type-specimen may be given as follows: Form of body slender and elongate; total length from extremity of snout to that of the vertebral column about 15 cm. Vertebral centra varying somewhat in length, being more compressed in a longitudinal direction underneath the second dorsal fin. About twenty-five centra occupy the interval between the bases of the two dorsal fin-spines, and it is noteworthy that these latter abut almost directly against the column. . . . The spines themselves are of relatively large size, smooth, sharply pointed distally, and only slightly arcuate or recurved."[4] They were evidently deeply implanted in the soft parts, but have become to a slight extent displaced from association with the front margin of the fins prior to fossilization.

[3] Eastman, *l. c.*

[4] Eastman, C. R., Am. Jour. Sci. (4), Vol. XXXI, 1911, p. 401.

"Portions of the fin-membrane or shagreen-covering of the pectoral pair, as well as the greater part of the pelvic, anal, and caudal fins are preserved. The anal is nearly opposite the posterior dorsal, and except for being more sharply pointed, resembles it in form and proportions. The pelvic pair is decidedly acuminate, and placed midway between the anal and pectoral pair. The pelvics slightly exceed the second dorsal in size, which latter is somewhat higher and longer than the first dorsal; and the depth [width] of the pectorals is about one third greater than that of the pelvic pair. Nearly the entire front margin of the right pectoral fin is preserved, but the distal portion of the left pectoral is either concealed or broken away. The same is true of the terminal part of both lobes of the caudal."[5] The general outline of body and position of all the fins is shown in Plate LVII, fig. 1. The shaded area immediately behind the head and thoracic region indicates a fracture in the containing rock.

The configuration of the head is well shown by a continuous mass of calcified cartilage and closely crowded shagreen granules preserved in natural position. Teeth are not visible, the head being exposed from the dorsal aspect without indications of mouth-parts. Two forwardly placed openings are probably to be interpreted as nasal and orbital respectively.

Fine shagreen granules bearing each a single acuminate recurved spine occur in regular series everywhere over the surface of the body, and cover the fin-membranes as well. Just above the vertebral column and evidently indicating the median

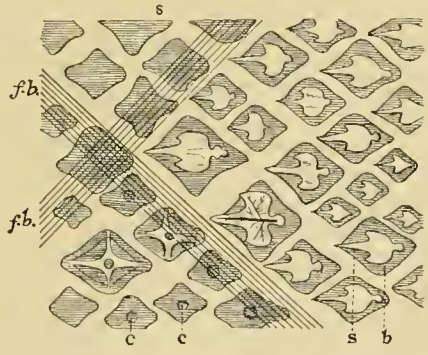

Fig. 1. Surface view of the dermal denticles of *Scyllium sp.* (From Bridge after Klaatsch, Cambridge Natural History, Vol. on Fishes, p. 184, fig. 99.) *b*, basal plate; *c*, canal which perforates basal plate and becomes the axial pulp-cavity of the spine; *f.b.*, intersecting fibrous bands of the dermis; *s*, spine; in the spine of one scale the dentinal tubules are shown. The smaller denticles are those most recently formed.

line of the back is a longitudinal series of spinules corresponding to ridge-scales, which extends from the anterior dorsal fin caudad nearly to the base of the upper lobe of the tail.

[5] Eastman, C. R., *l. c.*, pp. 401–402.

These spinules are not very greatly enlarged, but in advance of the first dorsal fin they become interspersed with, and finally replaced by, a series of much larger shagreen-scales, the surface of which is elevated into a number of sharp ridges radiating from a common point of intersection. These stellate spicules are longest along the front margin of the first dorsal fin, but smaller ones of similar form, or more frequently with two rays meeting at right angles, are distributed over the region of the head. These structures are no doubt identical with those described by von Zittel as "vierstrählige Schuppen" in the Munich example already referred to. Klaatsch's figure of the shagreen-denticles in a modern dogfish is reproduced herewith to illustrate the manner of arrangement. Both the shagreen and calcified cartilage in various portions of the body are exquisitely preserved in the specimen.

Family SCYLLIDÆ (Dog-Fishes).

Genus PHORCYNUS[6] Thiollière.

Dorsal fins above the pelvics and anal respectively, which latter are small. Form of body slender, length of head contained about five times in the total length. Tail of moderate length, with axis flexed upward in well-developed superior caudal lobe.

3. **Phorcynus catulinus** Thiollière. (Plate LVII, fig. 2.)

1854. *Phorcynis catulina* Thiollière, Poissons Fossiles etc. dans le Bugey, p. 9.

1889. *Phorcynis catulina* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 458.

1911. *Phorcynus catulinus* C. R. Eastman, Am. Journ. Sci. (4), Vol. XXXI, pp. 402–3.

This is the only known species and type of the genus, which attains a length of about 40 cm. In the form and position of the fins it closely resembles the recent *Ginglymostoma*, except for the slightly more anterior origin of the first and second dorsals.

[6] *Phorcynis* Thiollière; *Phorcynus* Eastman, Am. Journ. Sci. (4), Vol. XXXI, 1911, p. 402 (*errore*). (*Error hic iteratus*). The Editor takes occasion to emphatically protest against the change which has been made in this generic name by Dr. Eastman. The change is contrary to the laws of priority (*cf.* Proc. Seventh Internat. Zoöl. Congress, p. 43, Art. 19). Thiollière in forming the name took the stem of the Greek noun φορκῦς, which is φορκῦν-, and added the feminine ending ις, thus forming a noun, which may be interpreted to mean "a sea-goddess." He might better have added the Greek inflectional ending η, but he did not. At this date, after the name has been accepted by two generations of scholars, it is rather late to propose a modification. At the insistence of Dr. Eastman I leave the name as he has spelt it, but record my protest against the liberty he has taken. If arbitrary changes like this are constantly to be made, there never will be any possibility of arriving at "a stable scientific nomenclature" in ichthyology, or any other of the natural sciences. *W. J. Holland.*

"Our knowledge of this species has depended hitherto solely upon the type specimen, which lacks the anal and is in other respects incomplete. It must be regarded, therefore, as an extremely fortunate occurrence that a second and more perfect example of this forerunner of modern Dogfishes should have been discovered a half-century after the first was found, and should provide the means of further enlightenment concerning this genus and species.

"The total length of the Carnegie Museum specimen, which bears the catalogue number 4780, is a trifle less than 40 cm. It is a little difficult to determine the exact length of the head, but it was apparently contained between five and six times in the total length. The outline of the cranial roof, including the orbits on either side, and that of the lower jaw, is clearly shown. In the ethmoidal region and elsewhere in the body, the rounded or polygonal tesseræ of the endoskeletal cartilage are beautifully displayed, and the same remark applies to the fine shagreen-granules occurring throughout the integument. Just beneath the orbital cavity are to be seen impressions of a few minute teeth, each provided with one principal and a pair of lateral cusps.

"The vertebral column is preserved intact almost to the extremity of the tail, being flexed upward to support the upper caudal lobe. Ninety-six vertebral centra are to be counted in continuous series, and it is probable that not more than five or six are missing from the posterior extremity. The centra are of the usual hour-glass form, and do not call for any special comment.

"Both the median and paired fins are very well preserved. The pectorals are large, lappet-like, not abruptly truncated distally as in modern representatives of *Scyllium*, but obtusely pointed, as is the case in Cretaceous species of *Palæoscyllium*. The low pelvic fins arise at a point opposite the middle of the first dorsal. The endoskeletal supports consist of at least a dozen segmented radialia. The first dorsal arises at about the middle of the back, is of triangular form and moderate height, with twelve or more strong radialia. The second dorsal is similar to the first, but smaller, and the gently rounded anal lies directly beneath its posterior half. The tail is strongly heterocercal, in this respect differing from *Palæoscyllium* and resembling the recent *Ginglymostoma*.

"A minor feature which deserves perhaps casual mention is the preservation within the intestinal tract, near the vent, of portions of undigested food, including small ganoid scales, fragments of a small finely striated dorsal fin-spine (doubtless the young of some Cestraciont shark), and a number of small Echinoid spines, besides a few Foraminifera tests."[7]

[7] Eastman, *l. c.*

The close resemblance between the genus and species under consideration and the form described by Wagner as *Palæoscyllium formosum*, from the Kimmeridgian of Solenhofen, appears to have been overlooked by students of fossil fishes generally. This inadvertence is perhaps attributable, however, to the imperfect condition of the type-specimen which served for Thiollière's description, although in the text it is stated that the anal fin has not been preserved, and the outlines of all the others are indicated merely by a slight discoloration of the matrix. "Le contour du corps et de toutes les nageoires est indiqué seulement par la coloration différente de la pierre, et le relief n'est sensible que pour la colonne dorsale" (*l. c.*, p. 10). Judging from the published figure, the fin, which Thiollière interprets as one of the pelvics, is more properly to be regarded as a displaced pectoral belonging to the opposite side of the body. If a pelvic, it must have been displaced forwards.

Genus Palæoscyllium Wagner.

"First dorsal fin above or partly behind the pelvics; origin of second dorsal in advance of the anal, which is small. Tail of moderate length."[8] Teeth minute, with at least one pair of lateral cusps.

4. **Palæoscyllium formosum** Wagner.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 338.)

This species, which is the type of the genus, attains a length of about 40 cm. Pectoral fins large, in form resembling those of the existing *Scyllium*. Pelvic fins completely beneath the first dorsal; anal fin beneath the hinder portion of the second dorsal. Vertebral column composed of about one hundred asterospondylic centra.

Known only by the original of Wagner's figure and description, this species is worthy of notice in this connection on account of its close affinity to the preceding genus. The Cretaceous *Thyellina* of Agassiz is also a near ally.

Suborder *BATOIDEI*.

Family SQUATINIDÆ.

Genus Squatina Duméril.

All known fossil Squatinidæ exhibit the characters of this, the single surviving genus, and are consequently referred to it. The earliest species are of Upper Jurassic age. They resemble sharks in having lateral gill-clefts, but agree with *Rhinobatus* in the forward extension and lateral expansion of the pectoral fins;

[8] A. S. Woodward, Cat. Foss. Fishes, Vol. I, p. 338.

and their general structure points to their being probably survivors of ancestral rays.

5. **Squatina alifera** Münster. (Plate LXVII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 66.)

"Head gently rounded and blunt in front. Dermal granules varying from simple or stellate hooklets to blunt, rounded tubercles; no great mass of the latter observed in advance of the head or paired fins. Caudal fin very large" (A. S. Woodward, *l. c.*, Pt. I, p. 67).

One excellently preserved specimen belonging to this species, in some respects more perfect than the type, is to be seen on exhibition in the Hall of Vertebrate Paleontology of the Carnegie Museum. The structure of the head, pectoral and pelvic arches, fin-rays, the dentition, etc., is very well shown. The anterior dorsal and caudal fins are not indicated. The posterior dorsal fin is triangular, of comparatively large size, and situated about midway the length of the tail, as in the type. The total length of the fish is about 88 cm.

6. **Squatina minor** Eastman. (Plate LVII, fig. 3.)

1911. *Squatina minor* C. R. Eastman, Amer. Journ. Sci. (4), Vol. XXXI, p. 403, Pl. III.

Type.—Complete skeleton; Carnegie Museum (Cat. No. 4737).

In general like the preceding species, but distinguished from it by its smaller size (total length 49 cm.), relatively narrower disk, and more posterior position of both dorsal fins. The first dorsal arises at a point about one-third of the distance between the hinder extremity of the pelvic fins and the tip of the tail; the second dorsal midway between the latter point and origin of the first dorsal. The dentition and other characters are as in the typical species.

The differential characters given in the foregoing diagnosis are considered of sufficient weight to warrant a specific separation between the form here described and its larger contemporary which accompanies it in the same locality, *S. alifera*. Not more than two or three examples of the latter form have thus far been brought to light, so far as published information goes, and the holotype of the recently described allied species is unique. Hence the genus *Squatina* must be regarded as having been represented very sparsely and by not more than three species at the time of its advent in the Upper Jura of Solenhofen.

7. Squatina speciosa H. von Meyer. (Plate LXVIII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 67.)

Several nearly perfect examples of this small ray are preserved in the Carnegie Museum, the Museum of Comparative Zoölogy at Cambridge, Massachusetts, and the British Museum. Those in the first-mentioned institution bear the catalog numbers 4052, 4053 (in counterpart) and 4054. One of them is noteworthy for displaying to excellent advantage, the contour of the body in the form of an impression but no new details are added to our previous knowledge of the species.

Family RHINOBATIDÆ.

"This family dates from the Upper Jurassic and is at present widely distributed, being represented by about five genera and twelve species. Most of these are inhabitants of tropical and subtropical seas." *Cf.* Cambridge Natural History, Fishes, p. 460.

Genus Rhinobatus Klein.

The nomenclature and synonymy of this genus, from which the family derives its name, is discussed by Garman in his memoir on the Plagiostomia published in 1913. Variously written as *Rhinobates*, *Rhinobatos*, and *Rhinobatus*, the establishment of the genus under the last-named style is credited by Garman to J. T. Klein, 1776, the type being fixed as *Raia rhinobatos* Linné, 1758. Most writers, following Müller & Henle, have ascribed the authorship of the genus to Bloch (*ed.* Schneider, 1801).

8. Rhinobatus bugesiacus (Thiollière). (Plate LXVI, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 78.)

"Snout produced and acute, the two rostral ridges narrow, and separated by a broad groove throughout their length. Cleft of mouth straight. Disk moderately broad; length of pectoral fin nearly 2½ times its breadth at the point of insertion. Skin covered with fine shagreen, without large tubercles or spines" (A. S. Woodward, Cat. Foss. Fishes, Part I, p. 78).

As first recognized by A. Smith Woodward, the type of the so-called *Spathobatis mirabilis* is only a large variety of this species. It is preserved in counterpart, one of the halves belonging to the Paleontological Museum in Munich, and the other to the Carnegie Museum (Cat. No. 5396).* This particular specimen is

* *Note by the Editor.*—This specimen has undergone and survived great dangers. One evening in Brussels, when the writer was engaged in packing up the collection of Baron Bayet for shipment to Pittsburgh, the hour being late, he gave orders that no more specimens should be brought down from

admirably preserved, and has become familiar to students through the published figure given in von Zittel's Handbuch; hence it is only necessary to record the fact that the counter-impression, which formed part of the Bayet Collection, is now to be seen on exhibition in the Carnegie Museum. Its sex is denoted by the pair of claspers.

The caudal portion of another large ray, probably referable to this species, is cataloged under the number 4409, and consists of about one hundred vertebræ retained in their natural position, together with portions of the endoskeletal cartilage, belonging apparently to the pelvic girdle. Neither dorsal nor caudal fins are preserved in this specimen, and only the posterior dorsal is shown in the counterpart of the Munich example.

Genus Belemnobatis Thiollière.

9. **Belemnobatis sismondæ** Thiollière. (Plate LXVII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. I, p. 84.)

This species occurs typically in the Upper Jurassic of Cerin, France, and has not been previously reported from the Lithographic Stone of Bavaria. A single specimen from the latter locality, however, to be seen on exhibition in the Carnegie Museum (Cat. No. 4408), and remarkable for its perfect state of preservation, should undoubtedly be placed here. It measures 58 cm. in total length. The tail is spineless, and shows no indication of dorsal or caudal fins. The structure of the skull and nearly all of the endoskeletal parts are admirably displayed.

the upper floor of the *remise* where they were stored, and that work should cease for the day. Two of his overzealous assistants disobeyed, and, going up to the loft, attempted in the darkness to bring down this heavy and almost priceless slab. Descending the stairs in the dim light they stumbled and came rolling down the steps with their burden, which fell, and was shattered into scores of fragments upon the pavement of the lower court. The packers were instantly ordered from the spot, and sent away for the night. By the light of a lantern the writer, assisted by Dr. Eastman, working until nearly midnight, succeeded in gathering up the fragments, fitted them together, and then laying a large sheet of transparent paper over them made a careful tracing of their outlines, designating each piece by a number corresponding to numbers placed upon the tracing. On the following morning these pieces were carefully packed in cotton and together with the tracing were brought to America. With the outline before us, the writer, assisted by Mr. O. A. Peterson, succeeded in adjusting each bit to its place, and no one unacquainted with the fact, would imagine that at one time this noble specimen had lain a mass of comminuted fragments upon the pavement of a Belgian court-yard. It is in every way as good as if it had not been "smashed into smithereens." *W. J. Holland.*

Subclass TELEOSTOMI.

Order I. CROSSOPTERYGII.

Family CŒLACANTHIDÆ.

This family is remarkable among fishes for its conservatism and great longevity. From their first appearance in the Upper Devonian, the Cœlacanthidæ range practically unchanged through the intervening formations to the Upper Cretaceous. The most satisfactorily preserved remains are those obtained from the Lias and Upper Chalk of England, and from the Lithographic Stone of Bavaria. Those from the latter horizon have been exhaustively treated in a memoir by Dr. Otto M. Reis of Munich.[9]

Genus UNDINA Münster.

10. Undina penicillata Münster.

(For references to the synonymy see A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Part II, p. 410.)

Four well-preserved examples of this somewhat rare form are comprised in the Bayet Collection of the Carnegie Museum, and are cataloged under the following numbers: 4055, 4703 (in counterpart), 4791, and 4792. One of them is interesting because it shows the outlines of the ossified air-bladder, but none displays features not previously known.

Order HOLOSTEI (LEPIDOSTEOIDEI).

Family SEMIONOTIDÆ.

To this family belongs a series of deep-bodied forms represented by *Dapedius*, *Tetragonolepis*, *Homœolepis*, etc., which attain a notable development in the Lias, but become extinct with the last-named genus in the Upper Jura. But a solitary example of *Homœolepis* is known from Upper Jurassic rocks, and this is clearly indicative of a new species, the description of which follows:

Genus HOMŒOLEPIS Wagner.

A form in general resembling *Tetragonolepis*, but distinguished from it by the much less protuberant character of the ventral region, the relatively lower

[9] O. M. Reis, "Die Cœlacanthinen, mit besonderer Berücksichtigung der im Weissen Jura Bayerns vorkommenden Gattungen," Palæontographica, Vol. XXXV, 1888.

position of the pectoral fins, and by the greater number of scales in the vertical series below the vertebral axis. The pre-operculum is also much wider than in either *Dapedius* or *Tetragonolepis*.

The typical species is *H. drosera* (Egerton), from the Upper Lias of Wurtemberg, which by some authors is included in the same genus with *Tetragonolepis*.

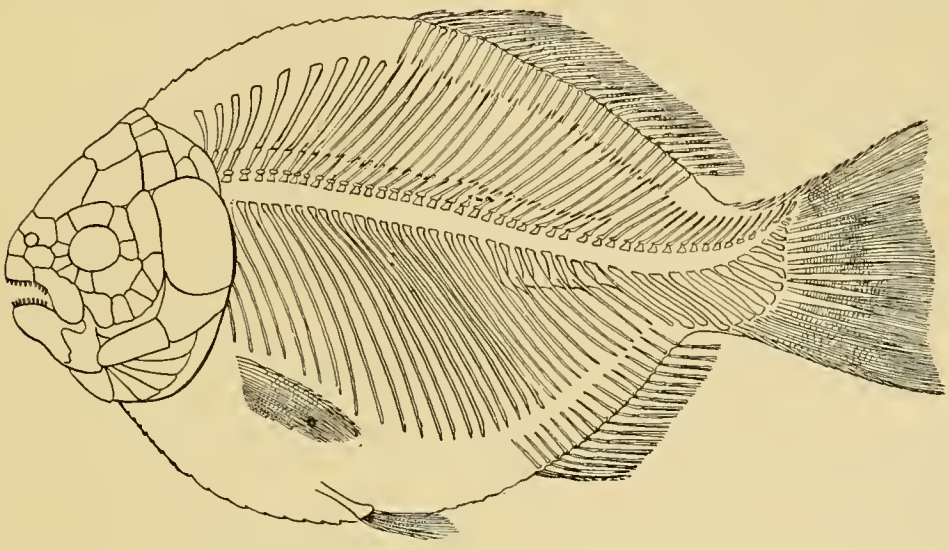

FIG. 2. *Dapedius politus* Leach. (After Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 131.)

The characters exhibited by the undermentioned species, which forms the terminal member of the group, may be regarded as confirming Wagner's recognition of this genus as distinct from *Tetragonolepis*.

11. **Homœolepis suborbiculata,** sp. nov. (Plate LVIII, fig. 3.)

Type.—Complete fish in counterpart; Carnegie Museum Cat. No. 4762, 4762*a*.

A large species attaining a length of about 33 cm. Maximum depth of trunk about equal to its length (exclusive of the caudal fin), and three and one-half times as great as the depth of the caudal pedicle. Head with opercular apparatus rather less than four times in the total length; the external bones almost smooth, with very few small sparse tubercles. Marginal teeth small, styliform, unicuspid. Pelvic fins arising midway between the pectorals and the anal; dorsal and fins each with about thirty rays, of which the more anterior ones are the most elevated, the dorsal fin being decidedly acuminate in front in consequence of this radial elongation.

Genus Lepidotus Agassiz.

12. **Lepidotus notopterus** Agassiz.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 92.)

This species is represented in the Bayet Collection of the Carnegie Museum by a single contorted individual, in which the squamation of the posterior part of the trunk is well displayed. It is cataloged as No. 697.

13. **Lepidotus ovatus,** sp. nov. (Plate LVIII, fig. 2.)

A species attaining a length of about 38 cm. and closely resembling *L. minor* in form and proportions, but with more strongly developed median fins, without dorsal ridge-scales, and the heavier squamation of the trunk arranged in more numerous longitudinal and transverse series. Flank-scales apparently smooth and not serrated. Fin-fulcra very large, those of the dorsal fin seven in number and more than half as long as the anterior dorsal fin-rays; those of the anal fin twelve in number and proportionally shorter. Pelvic fins arising midway between the pectoral pair and the anal, in this respect differing from the condition observed in *L. notopterus.*

The holotype and only known example of the species, the distinguishing characters of which have just been summarized, is a nearly complete fish, preserved chiefly in impression, which bears the catalog number 4730. It has a total length of 29 cm. to the base of the caudal fin, in which the length of the head with opercular apparatus is contained four times. The maximum depth of trunk is 11 cm. The number of oblique scale-rows counting along the lateral line is about forty, and of longitudinal scale-rows in the middle of the body about twenty-four.

Family MACROSEMIIDÆ.

Genus Ophiopsis Agassiz.

14. **Ophiopsis procera** Agassiz. (Plate LXX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 166.)

This genus and species was instituted by Agassiz upon the evidence of two incompletely preserved skeletons from the Lithographic Stone, one of which had a total length of about 30 cm. and the other of 10 cm. The smaller specimen was regarded by Agassiz as indicating an immature individual, and the larger as representing the full-sized or adult stage of the species. We here follow the procedure of Agassiz in referring to *O. procera* a small example measuring 14 cm. in total length, which bears the catalog number 4690. Another larger example in the collection is cataloged as No. 4691.

15. **Ophiopsis tenuiserrata** (Agassiz).

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 168.)

This species is represented in the collection by a single imperfectly preserved fish, in counterpart, having a total length of 17 cm., and cataloged as No. 5021 + 5021*a*.

16. **Ophiopsis attenuata** Wagner. (Plate LXII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 167.)

One excellently preserved example of this species is contained in the collection of the Carnegie Museum. It is cataloged as No. 4856.

Genus Histionotus Egerton.

17. **Histionotus parvus** Vetter.

1881. *Histionotus parvus* B. Vetter, Mittheil. K. Mineral.-Geol. Mus. Dresden, Pt. IV, p. 48, Pl. II, fig. 5.

Type.—Imperfect small fish; Dresden Museum.

The distinguishing specific characteristics of this form are enumerated by Vetter as follows: (1) its relatively small size; (2) its remarkably deep head and proportionally large size of the same; (3) its nearly vertical shoulder-girdle; and (4) the convex posterior margin and rounded inferior angles of the flank-scales. The holotype serving for Vetter's description exhibits a total length of 9.5 cm. and maximum depth of 3 cm., the depth of the head being 2.5 cm., and its length 2.7 cm. None of the median fins are preserved, but their position and general outlines are recognizable in the form of impressions. The dorsal fin is seen to be high and acuminate, extending for some distance over the middle of the back; the anal is pointed and remote, and the caudal fin is forked. The width of the caudal pedicle is contained two and a half times in the maximum depth. Teeth are not to be seen in the actual specimen, and according to the author the structures which are represented as such in the lithographic figure "verdanken ihre Entstehung der Phantasie des Zeichners."

So far as known the holotype of the species remains unique. Its characters are worthy of notice in this connection in order that the differences between it and the next following species may be more readily comprehended.

18. **Histionotus reclinis**, sp. nov. (Plate LXII, fig. 4.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 5002.

A small species, attaining a total length of about 10 cm., the length of the head with opercular apparatus being about equal to the maximum depth, and

contained slightly less than four times in the total length to the base of the caudal fin, which latter is scarcely forked and consists of about twenty-four rays. The short and low dorsal, with ten articulated rays, arises behind the middle point of the back, and the anal with fewer rays, is nearly opposite. Pectorals large, with about seventeen rays. Fulcra well-developed on all the unpaired fins. Scales in regular series, none especially deepened, posterior border nearly straight and strongly denticulated, the squamation extending over the upper lobe of the tail, and producing an upturned appearance of the latter. The specific title has reference to the last-mentioned character. Orbit large, high up; dentition not observed.

Genus Macrosemius Agassiz.

19. **Macrosemius rostratus** Agassiz. (Plate LXIII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 177.)

This species is represented in the collections of the Carnegie Museum by two excellent examples, cataloged under the numbers 4764, 4765.

20. **Macrosemius dorsalis,** sp. nov. (Plate LXV, fig. 2.)

Type.—Distorted fish; Carnegie Museum Catalog No. 4765.

A species of moderate size, attaining a total length of about 20 cm., in which the length of the head with opercular apparatus is contained about four times. Dorsal fin much elevated, and comprising about thirty-two rays, denticulated on their posterior borders, and somewhat expanded distally. Pelvic fins arising slightly in advance of the middle point between the pectoral and caudal fins, and the anal arising shortly behind. Exposed portion of the scales covered with fine striæ extending from the delicate pectinations of the posterior border.

This species, which is founded upon a unique, but somewhat crushed specimen from Solenhofen, approaches in certain respects the forms described from Cerin, France, by Thiollière; but is distinguished from them by the greater elevation of the dorsal fin, and the slenderer form of the rays, which are but little expanded distally.

Genus Propterus Agassiz.

21. **Propterus microstomus** Agassiz. (Plate LXII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 183.)

This elegantly formed fish is of comparatively rare occurrence in the Lithographic Stone of Bavaria, and has not been found elsewhere. No examples are contained in the collections of the British Museum, and but one, an exceedingly

perfect specimen in counterpart, in the Carnegie Museum. This is cataloged as No. 4468 + 4468*a*.

22. **Propterus speciosus** Wagner. (Plate LXIII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 184.)

Two nearly complete individuals in the collection are referable to this species. These are cataloged as numbers 4698 and 4825, and have a length of 12 cm. and 7 cm. respectively.

23. **Propterus conidens,** sp. nov. (Plate LXII, fig. 2.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4825.

A small species, attaining a length of about 10 cm. and maximum depth of 2.7 cm. Length of head with opercular apparatus contained nearly three times in the total length to the base of the caudal fin. Form of body elegantly fusiform, the dorsal and ventral borders gently arched, and width of the caudal pedicle a little more than half as great as the maximum depth of trunk. Fins as in *P. speciosus,* except that the dorsal fin is less elevated, its height falling considerably short of the maximum depth, and comprising apparently fewer rays. Caudal fin deeply forked. Scales finely denticulated.

The specific title is bestowed in allusion to the dental characteristics. The marginal teeth are sharply pointed, long and slender, and closely apposed to one another; as many as thirteen of them are to be counted along the rim of the jaw on one side.

Genus Notagogus Agassiz.

24. **Notagogus decoratus,** sp. nov. (Plate LXVIII, fig. 2.)

Type.—Well-preserved small fish; Carnegie Museum Cat. No. 5110.

Founded upon a unique specimen having a total length of 4.7 cm. Length of head with opercular apparatus exceeding the maximum depth of the trunk, and contained three times in the total length to the base of the caudal fin. Dorsal and ventral borders little arched, the trunk tapering very gradually toward the tail. Dorsal fin arising far forwards, its anterior portion comprising about fifteen rays, very widely spaced after the first three, which are closely approximated; second portion of the dorsal fin with about ten rays, also widely spaced with the exception of the first three; the rays of both portions gradually decreasing in length from the third or fourth ray onwards, and those of the anterior portion more elevated than those of the posterior portion; the longest fin-rays exceeding the maximum depth of trunk. Caudal fin slightly forked, comprising about sixteen rays, its margins

fringed with fulcra. Anal fin with seven rays; pelvics midway between the anal and the pectoral pair; the latter comprising about twelve much elongated rays. Scales thin, with five or six very long and sharp denticulations along the posterior border, and covered with exceedingly delicate horizontal striations on the inner surface. Teeth minute.

The holotype of this species is shown from the left lateral aspect in Plate LXVIII, Fig. 2, somewhat larger than natural size. A portion of the squamation having adhered to the opposite half of the containing matrix, the scales are seen from the inner side in the only part of the specimen which is now preserved. They are semitranslucent, and the remarkably strong denticulations are visible through the thickness of the overlapping series.

Family PYCNODONTIDÆ.

Genus Mesodon Wagner.

25. **Mesodon macropterus** (Agassiz). (Plate LXI, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 199.)

This species is represented in the collection of the Carnegie Museum by two relatively large-sized individuals (Cat. Nos. 4733, 4891), which measure about 22 cm. in total length, but are slightly injured in the region of the head; also by a

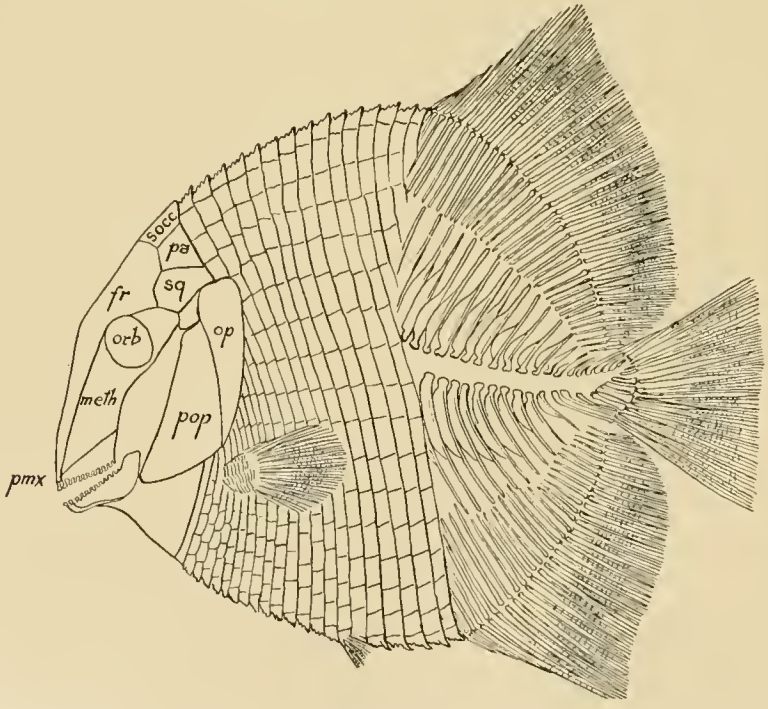

Fig. 3. *Mesodon macropterus.* (After A. S. Woodward, "Outlines of Vertebrate Paleontology," p. 105, 1898, fig. 74.)

very small specimen in counterpart (4456, 4456*a*), which is perhaps to be regarded as indicating a dwarf variety. The subjoined restoration of this species (Fig. 3) is copied from A. Smith Woodward.

Genus Gyrodus Agassiz.

"Trunk deeply fusiform or discoidal, with a slender abbreviated caudal pedicle. Head and opercular bones ornamented with tubercles; cheek and gular region covered with small, imbricating cycloidal scales; teeth more or less rugose and mammillated, those of the vomer in five, and those of the splenial in four regular series. Neural and hæmal arches of axial skeleton of trunk not expanding sufficiently to encircle the notochord. Fin-rays robust, closely arranged, articulated, and divided distally. Pelvic fins present; dorsal and anal fins low and fringe-like, except in front where they rise to an elevated point, these two fins arising at about the same point and not extending in advance of the hinder half

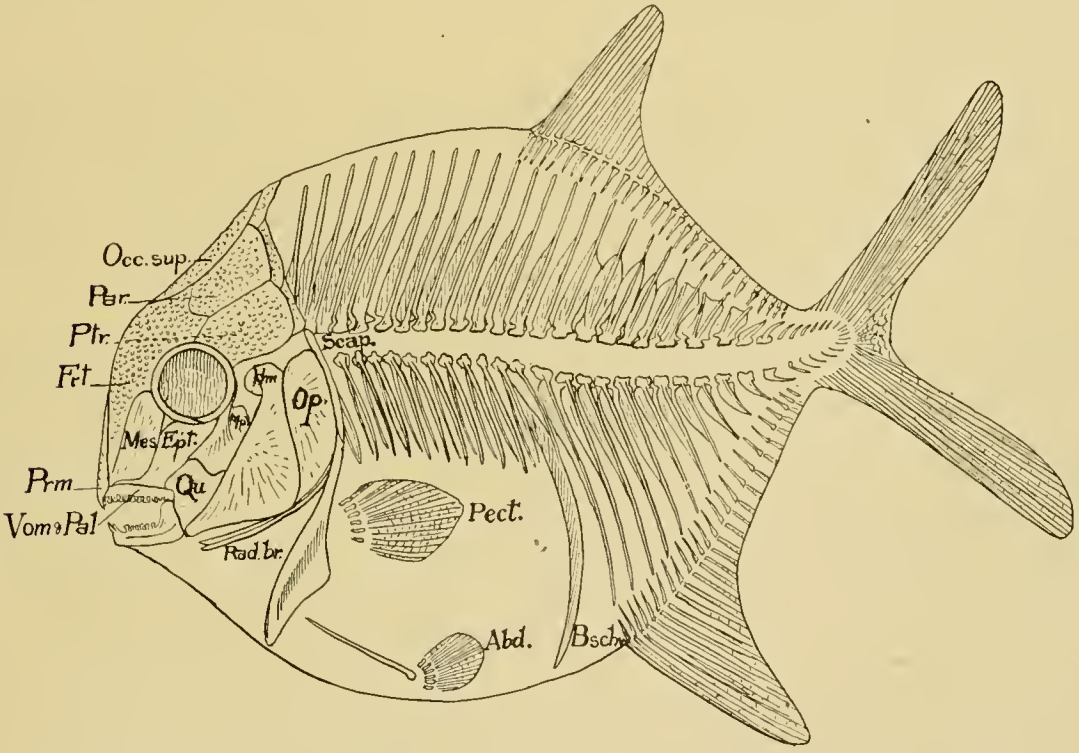

Fig. 4. *Gyrodus hexagonus* (Blainville). (After E. Hennig in "Palæontographica," Vol. LIII, 1906, Pl. XI, fig. 2.)

of the trunk; caudal fin deeply forked, with slender lobes. Scales tuberculated or rugose, covering the whole of the trunk" (A. S. Woodward, *l. c.*, Pt. III, p. 233).

26. **Gyrodus macrophthalmus** Agassiz. (Plate LXIX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 233.)

This species is represented in the collections of the Carnegie Museum by a well-preserved individual having a total length of 25 cm. (No. 4734) showing the characteristic scale-markings and part of the dentition. Hennig's proposal to suppress this, the type-species, and also *G. frontatus,* in favor of Blainville's term, *G. hexagonus,* cannot be sustained.

27. **Gyrodus frontatus** Agassiz. (Plate LXI, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 235–6.)

A species, so far as known, closely similar to the type, only differing in the relatively greater protuberance of the abdominal region, in the simple mammillation of the teeth, and in having the tubercular ornamentation of the scales without reticulations, extending over the ventral half of the fish (*cf.* A. S. Woodward, *l. c.*, Pt. III, p. 236).

This form is well represented in the collections of the Carnegie Museum, the examples belonging to it being cataloged as follows: 10, 690, 691, 3003, 4685, 4735 (in counterpart), 4736, 4763 (in counterpart), 4796, 4797 (in counterpart), 4798 (in counterpart), 4799, 4893. The figure on Pl. LXI is unfortunately reversed.

28. **Gyrodus circularis** Agassiz. (Plate LXIX, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 238.)

A magnificent example of this species, having a total length of 75 cm., forms one of the most attractive exhibits of fossil fishes to be seen in the Hall of Vertebrate Paleontology in the Carnegie Museum. It is cataloged as 4407*x*. Another specimen (Catalog Number 4407), of even larger size shows the well-preserved squamation of the left side of the trunk.

Family EUGNATHIDÆ.

Genus Eugnathus Agassiz.

29. **Eugnathus longiserratus** (Agassiz). (Plate LXIV, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 301.)

Three well-preserved specimens referable to this species form part of the exhibition series of the Carnegie Museum, and are cataloged under the numbers 4686, 4719 (in counterpart), and 5021 respectively.

Genus Caturus Agassiz.

30. **Caturus furcatus** Agassiz. (Plate LIX, fig. 3; Plate LX, fig. 2; Plate LXI, figs. 4 and 5; Plate LXVIII, fig. 1; Plate LXXII, fig. 3; Plate LXXXIII, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 332.)

This, the typical species, is of common occurrence in the Lithographic Limestone of Bavaria and the Department of Ain, France; and, owing to its abundance and favorable state of preservation, nearly all details of its skeletal organization are accurately known. An excellent restoration is given by Dr. A. S. Woodward in his Catalog, Pt. III, p. 331, fig. 36. A view of the underside of the head of a specimen (No. 4451) is given on Plate LXVIII, fig. 7.

In the opinion of Dr. A. S. Woodward, various small forms of *Caturus*, which have been described under different specific titles, are to be regarded as immature examples of the type species, *C. furcatus*. As shown by comparison of a large series of specimens, the latter is no doubt represented in the Lithographic Stone by several well-marked varieties, which appear, nevertheless, to grade into one another, and for that reason can scarcely be separated into species clearly distinguishable from the type. It is more expedient, therefore, to group them all under one head, in which case the trivial names *C. macrurus*, *microchirus*, *obovatus*, *ferox*, and *gracilis* become synonyms of *C. caturus*. From the large suite of material belonging to the Carnegie Museum several well-preserved examples have been chosen for illustration in the present Memoir, among them one of the small varieties which was named by Agassiz *C. macrurus*. This is shown in Plate LXI, fig. 4. The remaining specimens in the collection are cataloged as follows: 696, 866, 871, 872, 4028, 4451, 4697, 4699, 4713, 4720, 4721, 4723, 4771, 4774, 4778, 4790, 4795, 4808, 4809, 4809*a*, 4859, 4861, 5013, 5014, 5020, 5049, 5053.

31. **Caturus pachyurus** Agassiz. (Plate LIX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, pp. 336–7.)

This is a much rarer form than the type species of *Caturus*, and is represented in the collections of the Carnegie Museum by a single well-preserved specimen, which bears the catalog number 4724, and is shown on Plate LIX.

Family AMIIDÆ.

Genus Megalurus Agassiz.

32. **Megalurus lepidotus** Agassiz. (Plate LXX, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 36.)

Only two examples of this early Amioid species are listed in Dr. Smith Woodward's Catalog as belonging to the British Museum. The Carnegie Institute is fortunate in possessing a number of well-preserved specimens, catalogued as follows: 4732, 4767, 4768, 4769, 4812, and 4862. The first four are in counterpart.

33. **Megalurus elegantissimus** Wagner. (Plate LXX, fig. 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 365.)

The following numbered examples in the Carnegie Museum are referable to this species: 693, 4854.

Family PACHYCORMIDÆ.

Genus Sauropsis Agassiz.

34. **Sauropsis longimanus** Agassiz.

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 375.)

This is an extremely rare form, occurring, so far as known, only in the Lithographic Stone of Bavaria, though a closely related species, as yet undescribed, is reported by A. Smith Woodward from the Oxfordian of Wiltshire. Neither the Carnegie nor the British Museum possesses examples of the species.

35. **Sauropsis depressus,** sp. nov. (Plate LX, fig. 3.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4766 + 4766*a*.

Form of body slender and elongate, the length of head with opercular apparatus considerably exceeding the maximum depth of trunk. Pelvic fins arising midway between the pectorals and the anal; dorsal fin arising opposite the low fringe-like posterior portion of the much extended anal, and consisting of comparatively few rays; the anterior rays of the dorsal and anal equal in elevation, but rapidly decreasing posteriorly. Other characters similar to those of the type species.

The holotype of this extremely slender species is a well preserved skeleton having a total length of about 32 cm., in which the trunk is exhibited from the lateral, and the head, which is reflexed, from the ventro-lateral aspect. It is in counterpart, and the skeletal structure can be studied in its entirety by combining both halves. In the type specimen of *S. longimanus* figured by Agassiz the head

is shown in profile, thus affording a tolerably clear idea of the arrangement of the cheek and opercular plates, but yielding no information as to the covering of the thoracic region; the present specimen, on the other hand, completes our knowledge of the underside of the head, and displays besides the branchiostegal and opercular apparatus to excellent advantage.

The anterior portion of the space between the mandibular rami is completely covered by a narrow, triangular gular plate, behind which occur the closely spaced series of branchiostegal rays, these latter being in juxtaposition superiorly with the angular element, interoperculum, and suboperculum in ascending order. In the thoracic region the interspace between the divergent series of branchiostegal rays is occupied apparently by a single, thin, delicate plate, which probably owes its origin to the fusion of a number of small scales. The structure of the mandible is not altogether clear, but the splenial is evidently a long delicate plate, beset with small conical teeth, while the angular occupies about one-third of the outer face of the ramus. The maxilla is long and slender, tapering in front, deepest behind, and in its middle portion is in contact with the sclerotic ring, which is ossified. The latter is apparently bounded posteriorly by a ring of small circumorbitals, the boundaries between which have become obliterated.

With regard to the structure of the fin in the type-species Agassiz remarks as follows: "Les nageoires reflètent en quelque sort à l'extérieur cette forme grêle du squelette, car leurs rayons sont tous sans exception excessivement fins: Les pectorales qui ont valu à l'espèce son nom sont très-developpées, fort longues, et en même temps très-larges. Les plus grands rayons débordent beaucoup l'insertion des ventrales. Autant les pectorales sont grandes, autant les ventrales sont petites."

These characters of the paired fins hold true for the new species under discussion, as well as for the type, the only difference being that the pectoral fin-rays are more numerous in the present form than in *S. longimanus*. Upwards of forty are to be counted in the specimen now in hand, and although Agassiz does not state the number observed by him in *S. longimanus*, only half as many are shown in the published illustration (Poiss. Foss., Vol. II, Pl. LX). The median fins are essentially alike in the two species, except for the more remote position of the dorsal in the example here made the type of a new species, as already noted. The caudal fin is most exquisitely preserved, and shows the upward prolongation of the axis for a short distance into the superior lobe. The scales and internal skeletal structure do not call for particular mention.

36. **Sauropsis curtus**, sp. nov. (Plate LXVI, fig. 1.)

Type.—Nearly complete fish; Carnegie Museum Cat. No. 4772.

Form of body deeper and more compact than in other known species, the trunk relatively short and tapering rapidly posteriorly, the width of the caudal pedicle equalling about one-third of the maximum depth. Length of head with opercular apparatus equalling maximum depth, and contained nearly four times in the total length to the base of the caudal fin. Form and position of the fins as in the type species (*S. longimanus*), except that the pectoral pair is less strongly developed, and the rays of all the fins show articulations throughout their entire length. Dorsal fin-supports about thirty, and anal fin-supports about fifty in number, all more closely spaced than the neural and hæmal spines. Number of the latter upwards of ninety from the anterior portion of the axis to a point underneath the hinder extremity of the dorsal fin, and their total number estimated to have been about one hundred and twenty-five. Lateral line conspicuous, parallel with the axis, and continued over the parieto-frontal bones of the head. Operculum subtriangular and much deepened; pre-operculum narrow and elongate, in contact through its entire length anteriorly with the vertically elongate postorbital. Snout obtuse; dentition as in the type-species.

The holotype answering to the above description is a magnificently preserved specimen, having a total length of about 28 cm., and of very great importance on account of the perfection with which the cranial and facial elements are displayed. A remarkable feature is the great elongation in a vertical (transverse) direction of all of the parts lying between the postorbital and posttemporals. The postorbital itself occupies the space which in the existing *Amia* is covered by a distinct portion of the integument overlying the pre-operculum and extending forward to the angle of the jaws.

Genus Hypsocormus Wagner.

37. **Hypsocormus insignis** Wagner. (Plate LXXI, fig. 3.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 391.)

An exceptionally perfect example of this species (No. 5398) having a total length to the base of the caudal fin of 53 cm., and displaying all of the fins and skeletal parts to advantage, is to be seen on exhibition in the Hall of Fossil Vertebrates in the Carnegie Museum. The pectoral fin-rays are stouter and more numerous than are shown in A. S. Woodward's restoration of this species, and the supports for the anal are somewhat longer. For purposes of comparison the figure given by Woodward is here reproduced.

An interesting structure not hitherto observed in connection with this species is the presence of a long and tapering air-bladder, the calcified walls of which show a series of transverse ridges not unlike those formed by muscle-fibres in modern Ganoids and Dipnoi. Confluent with the intestinal tract in front, the organ in question extends longitudinally close to the ventral body-wall along one side of the supports for the anal fin, and terminates in a closed sac immediately behind the latter.

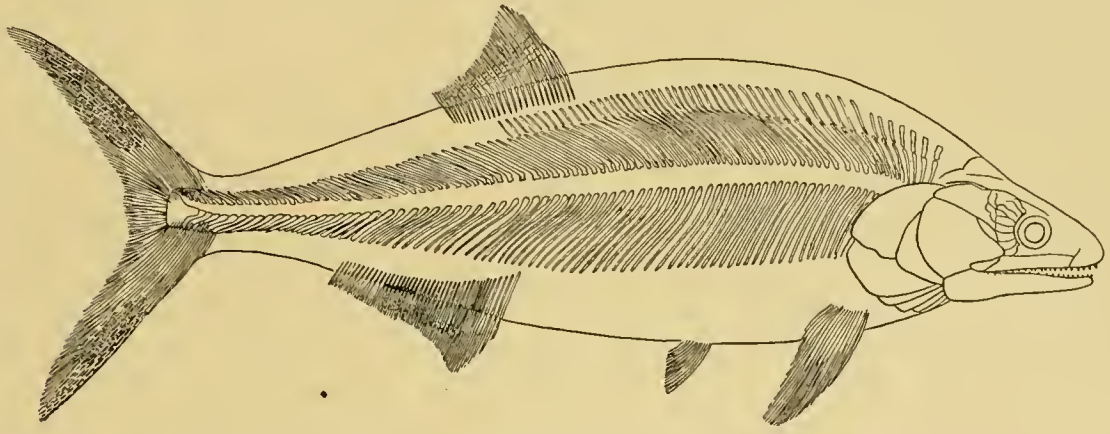

FIG. 5. *Hypsocormus insignis* Wagner. (After A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, fig. 40, p. 393.)

Somewhat similar structures have been observed in *Pachycormus* and *Asthenocormus*, and are interpreted in the latter by B. Vetter as spiral valves of the intestine (*cf. infra*, p. 461). The numerous internal septa ("convolutions" of Vetter), small size of the organ, and its prolongation into the region posterior to the anal fin, are characters which militate against this view of its nature. For the suggestion that the structure in question is a calcified air-bladder the writer is indebted to his friend, Dr. C. H. Eigenmann, than whom no one is better qualified to pass judgment upon the actual specimens submitted for examination.

According to this eminent authority, the form and position of the air-bladder exhibit a wide range of variation among closely related genera of modern teleosts, even within the limits of a single subfamily, such as the Curimatinæ[10] of the Characidæ or Sternopyginæ[11] among the Gymnotidæ.

[10] Eigenmann, Carl H. and R. S., "A Revision of the Edentulous Genera of Curimatinæ," Annals N. Y. Acad. Sci., 1889, Vol. IV, pp. 409–440.

[11] Ellis, Max Mapes, "The Gymnotid Eels of Tropical America," Mem. Carn. Mus., Vol. VI, No. 3, 1913, pp. 186–189.

38. **Hypsocormus macrodon** (Wagner). (Plate LXXI, figs. 1 and 2.)

(For synonymy *cf.* A. S. Woodward, Cat. Foss. Fishes Brit. Mus., Pt. III, p. 394.)

Two representatives of this species occur in the collections of the Carnegie Museum, both of large size and well-preserved, and both on exhibition in the Hall of Fossil Vertebrates. One, having a total length of about 65 cm., is preserved without any distortion other than vertical crushing, and displays the head-parts and all the fins in very nearly their entirety. The other, which is more than twice the size of the first, is contorted in such manner that the body is coiled upon itself, the head and inferior caudal lobe being closely approximated. The relatively short head, with its large, forwardly placed orbit, together with the slender and elongate form of body, terminating in a widely expanded caudal fin, give to this species a characteristic expression. The bones of the head are finely tuberculated, and the scales delicately striated. The ventral fins are situated midway between the pectorals and anal fin. To this species may also be referred an imperfect detached head, cataloged as number 4794.

Genus Asthenocormus A. S. Woodward.

39. **Asthenocormus titanius** (Wagner).

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 380.)

Of this species, one of the largest of Jurassic Pachycormidæ, only two tolerably complete individuals are known, the holotype which is in Munich, and the interesting specimen studied by Vetter, which belongs to the Dresden Museum. In neither specimen is the dentition satisfactorily shown, nor is any trace preserved of the pelvic fins. Nevertheless there is reason to believe that the latter organs were present, and that a series of enlarged prehensile teeth was borne anteriorly by the jaw-parts. Such, at least, are among the characters which have been observed in the case of the next following species.

Mention should be made in this connection of a peculiar structure described by Vetter in the example studied by him, the significance of which would seem to have been misinterpreted. The position of the stomach and intestinal tract is clearly indicated in the specimen belonging to the Dresden Museum and according to the author just named, the intestine is provided posteriorly with a remarkably well-developed spiral valve. The small diameter of this tube, its tapering posterior extremity and total absence of coprolitic matter in its interior, are features difficult to reconcile with the view that we here have to do with a much convoluted spiral valve. A more plausible interpretation is to regard it as a calcified air-bladder

similar to that already observed in *Hypsocormus*, and the convoluted appearance of which is due to the presence of numerous transverse fibrous bands and ridges. From analogy with recent forms in which similar bands occur, it may be presumed that the interior was partitioned off by transverse septa extending between the ridges.

40. Asthenocormus retrodorsalis, sp. nov.

Type.—Imperfect fish; Carnegie Museum (Cat. Nos. 4863, 4863*a*, 4863*b*).

A species nearly equalling the type of the genus in size, and resembling it in general form and proportions, but distinguished from it chiefly by characters of the median fins and the dentition. Pelvic fins present, and the low triangular dorsal fin arising behind the anal.

This species is established upon the evidence of a single nearly complete individual, preserved in counterpart, from the Lithographic Stone of Kelheim, Bavaria, and contained in the Bayet Collection of the Carnegie Museum. The head and anterior portion of the trunk have been considerably crushed and deformed, but the remainder of the body is preserved without distortion and shows the lateral aspect, the position of all the fins being clearly indicated.

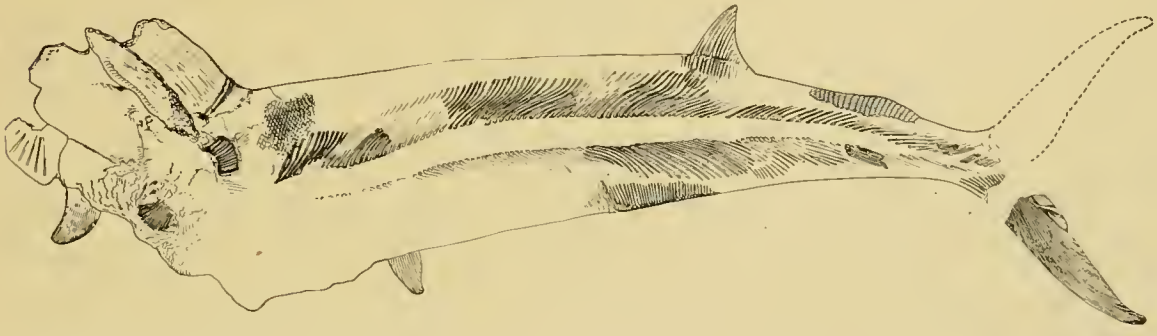

FIG. 6. *Asthenocormus retrodorsalis*, sp. nov. C. M. Cat. Foss. Fishes, Nos. 4863 and 4863*a*. × $\frac{1}{5}$.

As denoted by the specific title, the dorsal fin is remote, arising behind the origin of the anal, and is much shorter than the latter. The dorsal fin consists of comparatively few rays, which posteriorly rapidly decrease in size. The anal fin has become detached, but its internal supports are preserved intact; these depend almost vertically from the hæmal spines, and are seen to be about thirty in number. The small pelvic pair is situated midway between the pectorals and anal fin. The proximal portions of both pectorals are preserved, but the distal two thirds have been broken away. The caudal fin is complete, exhibiting the very fine subdivision of the rays at its hinder border, but no fulcra along the anterior margin.

New and interesting features are presented by the dentition of this species.

Teeth are not preserved in either of the containing slabs which display nearly the entire body of the fish, but are found associated with some of the opercular plates and jaw-parts which have been fractured off from the main portion of the fossil, the whole mass being embedded in a separate block of limestone which evidently lay in juxtaposition with the two larger slabs.* It is difficult to identify all of the plates which are found partly overlying one another and forming a more or less confused mass in this smaller block of limestone, but it is evident at a glance that other elements bordering the mouth-cavity besides those in direct relation with the jaws were dentigerous. Small, recurved conical teeth were probably borne on the entire palatal roof, including the pterygoids and parasphenoid, and some may have lined the throat cavity, as is perhaps to be inferred from the occurrence of numerous small conical teeth in clusters, which show no signs of havingbeen embedded at the base in alveolar sockets and can scarcely be considered as jaw-teeth.

As regards form and mode of occurrence, the teeth just described agree closely with the conditions noted by Vetter in two individuals of the type-species studied by him. This will appear from the following passage which is extracted from the account of the dentition of *A. titanius* given by the author just named.[12]

* Since Dr. Eastman wrote these lines the Director has had the specimens carefully examined, with a view to ascertaining possible points of contact between the pieces embedded in the plaster mount. This work was very carefully done by Mr. O. A. Peterson. It is now discovered that the upper caudal lobe of the specimen in both slabs is very ingeniously made out of plaster of Paris. Whether it is possibly a cast made from fragments, which were not preserved, and for which this plaster of Paris reproduction was substituted, it is not now possible to say. The examination made shows that, as restored by the original collector, he was careless in noting the contacts, with the result that the lower lobe of the caudal as placed was quite too near the vertebral column, a piece containing the fulcra evidently having been dropped out.

Figure 6, which has recently been made by Mr. Prentice, shows the exact facts as to the caudal lobes.

In reference to the head (4863*b*) which has been associated by Dr. Eastman with the specimen, it must be said that this association is not determinable by any contacts which can be discovered in the anterior parts of either of the larger slabs containing the body of the fish. All the plaster has been removed and a diligent search has been made for contacts, but none are discoverable. If it belonged to the larger blocks, it must have been lying at some remove from the rest of the body of the fish. There is a presumption in favor of its having been a part of this specimen, arising from the color and composition of the matrix. Unfortunately Baron Bayet does not appear to have always appreciated the importance of preserving exact records as to the origin of specimens, and we have no clue in any list of purchases made by him, or any of his correspondence, which is in our hands, which would serve to establish the fact that the head and the body associated by Dr. Eastman belonged together. This association, while it appears plausible, nevertheless does not rest upon evidence which is incontestable.

W. J. Holland.

[12] Vetter, Benjamin. Die Fische aus dem lithographischen Schiefer im Dresdener Museum (Mittheil. K. Mineral-Geol. Museum Dresden, 1881, Pt. IV, p. 99).

"Die Zähne zeichnen sich weder durch Farbe oder Glanz, noch durch Grösse aus, und sind nur mit Mühe herauszufinden. Sie liegen zerstreut, theils ganz vorn, besonders aber vor, unter und hinter dem Auge, ihre Spitze meist nach oben und vorn, zum Theil auch nach unten gekehrt; alle diese mögen noch auf den Kieferrändern gesessen haben. Nun folgen, aber, durch das Operculum hindurch sichtbar, zahlreiche bis zu seinem Hinterrande reichende Zähne, welche noch am ehesten eine regelmässig senkrechte Lage zeigen; diese müssen am Parasphenoid und an den gegenüber liegenden Flächen der Basibranchialia resp. der Schlundknochen befestigt gewesen sein. In der That bemerkt man denn auch an der mitten durch das Auge ziehenden Strecke des ersteren gleichfalls eine Anzahl kleiner Zähne.

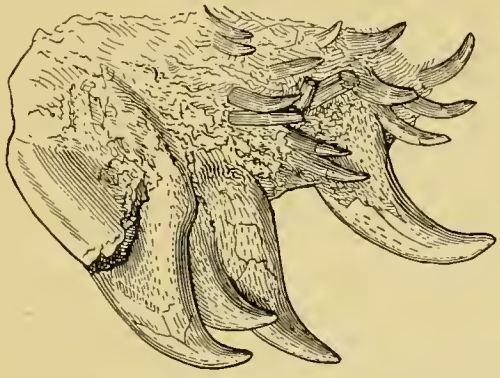

Fig. 7. *Asthenocormus retrodorsalis*, sp. nov. Anterior dentition. C. M. Cat. Foss. Fishes, No. 4863*b*. × $\frac{1}{1}$.

"Alle diese Zähne sind meist schwach gekrümmt, sehr spitz und schlank bis plump kegelförmig, mit glatter Oberfläche. . . . Da sie überall nur in grösserer Anzahl beisammenliegen, so scheinen sie auch auf den Kieferrändern nicht in einfachen Reihen, sondern nach Art von Bürstenzähnchen gruppenweise gesessen zu haben (im ganzen damit übereinstimmend ist das sporadische Vorkommen von Zähnen bei Exemplar II)."

So far the dental characters of the type-species are seen to stand in perfect accord with those of the new form now under discussion. That which is altogether novel, however, and in fact unique among the *Pachycormidæ*, is the presence of a series of enlarged teeth with laterally compressed bases, situated at the front margin of the upper and lower jaws and extending also, as far as one may judge from their position in the matrix, for some distance posteriorly along the outer rim of the jaws. The form of these enlarged prehensile teeth recalls in a general way the compressed broad-based teeth which have been provisionally named *Ancistrodon*, except that the crown is more elevated, conical, and regularly arched. Some of them, also, appear to have had very deep roots. Figures of these prehensile.

teeth are given in the accompanying illustration (Fig. 7.) This peculiar differentiation of the dentition in *Asthenocormus* is most nearly approached among kindred forms by the Cretaceous *Protosphyræna*, in which the more anteriorly placed teeth are especially large, much compressed, and implanted in deep sockets. In respect to various characters, the genera *Pachycormus*, *Hypsocormus*, *Asthenocormus* and *Protosphyræna* represent, in the order named, successive stages of modification, at the same time closely mimicking in general form of body the Tertiary Xiphiidæ or "sword-fishes."

Family ASPIDORHYNCHIDÆ.

Genus Aspidorhynchus Agassiz.

In this genus, according to Dr. A. S. Woodward, the vertebral centra are always in the form of delicate rings, each bearing its own arch. The ribs are very short and thin. In the abdominal region the neural spines appear to be separate from their supporting arches, though this is not quite certain; in the caudal region, both hæmal and neural spines are fused with their arches, and the latter with their respective centra. As might be expected from the stout proportions of the rays, the supports for the dorsal and anal fins are especially robust; and they are shown to be more numerous than the vertebral segments beneath them. The scales are all thick and rhombic, strengthened by a slight internal median rib, and those of the flank united by a large peg-and-socket articulation. The lateral line pierces each scale it traverses.[13]

41. **Aspidorhynchus acutirostris** (Blainville). (Plate LXIV, fig. 3.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 419.)

This species is represented in the collections of the Carnegie Museum by a number of fine examples, certain of which are to be seen on exhibition in the Hall of Fossil Vertebrates. The complete suite of specimens is cataloged as follows: 12, 14, 4741, 4743, 4774, 4745, 4746, 4777 + 4777*a*, 4779, 4810, 4823, 4814, 4864, 4867, 4868 + 4868*a*.

Genus Belonostomus Agassiz.

42. **Belonostomus muensteri** Agassiz. (Plate LX, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, pp. 429–30.)

This species is represented in the collection of the Carnegie Museum by the following examples: Cat. Nos. 4115, 4795, 4796, 4850, 4865, 4866.

[13] For a description of the cranial osteology and other interesting details of the structure of two species of *Aspidorhynchus* reference may be made to Assmann's paper "Ueber Aspidorhynchus" in *Archiv für Biontologie* 1906, Bd. I, Heft 1, pp. 49–80.

Suborder *ISOSPONDYLI.*

Family PHOLIDOPHORIDÆ.

Genus Pholidophorus Agassiz.

43. **Pholidophorus macrocephalus** Agassiz. (Plate LVIII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, pp. 467–8.)

The synonymy of this species, as given by A. S. Woodward, agrees with the conclusions of Wagner and Vetter, excepting that the latter has proposed the trivial name *P. magnus* to designate the species, a procedure which is contrary to recognized codes of nomenclature. The following examples in the Carnegie Museum are referable to this species: Car. Mus. Cat. Nos. 694, 4793, 4811, 4898, 5067, 5087.

Family OLIGOPLEURIDÆ.

Genus Œonoscopus Costa.

(Syn. *Attakeopsis* Thiollière; *Macrorhipis* Wagner.)

44. **Œonoscopus cyprinoides** (Wagner). (Plate LXV, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 495.)

Two well-preserved individuals belonging to this species are contained in the Bayet Collection, and are cataloged under the following numbers: 4700, 5086. Examples of this species are rare in the Lithographic Limestone.

Family LEPTOLEPIDÆ.

Genus Leptolepis Agassiz.

45. **Leptolepis dubia** (Blainville).

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 509.)

This and the closely related *L. sprattiformis* are among the commonest fishes occurring in the Lithographic Stone of Bavaria, and both are abundantly represented in the collections of the Carnegie Museum, many of the specimens being remarkably well preserved, and displaying nearly the entire cranial and skeletal osteology. To the species under consideration belong the following examples: Carnegie Mus. Cat. Nos. 9, 13, 4448, 4687, 4693, 4694, 4695, 4712, 4714, 4715, 4782, 4783, 4784, 4785, 4786, 4801, 4803, 4804, 4805, 4806, 4807, 4820, 4821, 4822, 4831, 4832, 4838, 4839, 4840, 4841, 4842, 4873, 4871, 4875, 4895, 5000, 5004, 5005, 5010, 5011, 5012, 5019, 5027, 5028, 5029, 5030, 5031, 5032, 5033, 5035, 5040, 5041,

5044, 5065, 5069, 5070, 5075, 5089, 5090, 5091, 5092, 5093, 5094, 5095, 5096, 5101.

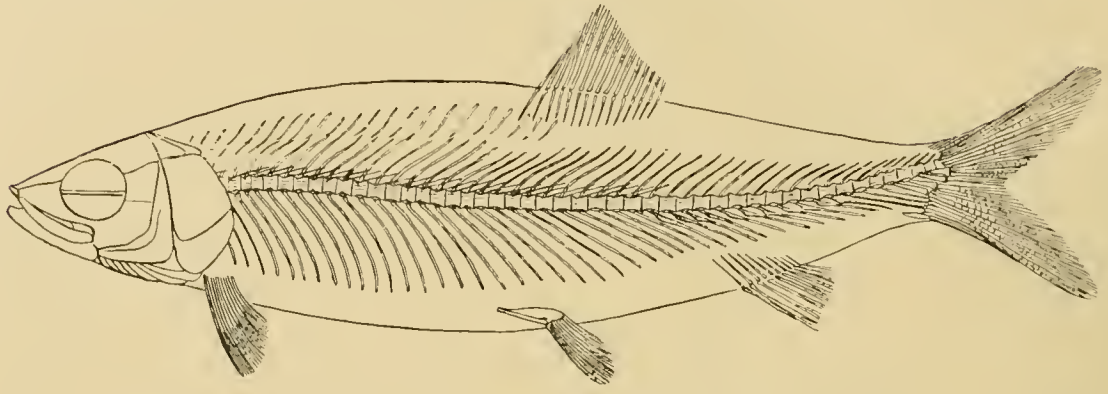

Fig. 8. Restoration of *Leptolepis dubia*. (After A. S. Woodward.)

46. **Leptolepis sprattiformis** (Blainville). (Plate LXXIII, figs. 1–3.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 513.)

The following examples in the Carnegie Museum are referable to this species: Car. Mus. Cat. Nos. 861, 863, 864, 4030, 4031, 4107, 4108, 4109, 4110, 4111, 4112, 4114, 4116, 4117, 4118, 4119, 4120, 4121, 4122, 4123, 4124, 4125, 4126, 4128, 4149, 4242, 4243, 4244, 4246, 4247, 4249, 4251, 4252, 4253, 4254, 4255, 4256, 4258, 4260, 4261, 4262, 4263, 4264, 4417, 4665, 4815, 4834, 4835, 4877, 4878, 4879, 4880, 4881, 4882, 4883, 5007, 5009, 5006, 5024, 5025, 5026, 5043, 5047, 5048, 5059, 5062, 5063, 5064, 5082, 5084, 5104, 5106, 5113.

Genus Æthalion Münster.

47. **Æthalion knorri** (Blainville). (Plate LXXIII, fig. 4.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 518.)

This species is not particularly common in the Upper Jura of Solenhofen, and is represented in the collections of the Carnegie Museum by a number of examples, which bear the following catalog numbers: 865, 4688, 4689, 4800, 4830, 4837, 4843, 4845, 4846, 4852, 4869, 4870, 4872 + *a*, 4889, 4897, 5003, 5008, 5017, 5022, 5023, 5034, 5038, 5039, 5042, 5045, 5046, 5051, 5057, 5066, 5071, 5077, 5079, 5099.

Genus Thrissops Agassiz.

This is one of the more abundant genera in the Lithographic Limestone of France and Bavaria, and is represented in the Solenhofen fauna by three species, of which the following is the most important:

48. **Thrissops formosus** Agassiz. (Plate LXII, fig. 2.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 521.)

A large series of *Thrissops* belonging to this species are contained in the Bayet Collection of the Carnegie Museum, several complete and admirably preserved individuals being among the number. These specimens bear the following catalog numbers: 4030, 4702, 4789.

49. **Thrissops salmoneus** (Blainville). (Plate LXXII, fig. 1.)

(For synonymy *cf.* A. S. Woodward, *l. c.*, Pt. III, p. 522.)

This species is represented in the collection by specimens bearing the following numbers: 870, 4717, 4773, 4813, 4818 + *a*, 4894, 5088, 5090.

Genus Parathrissops *novum*.

A genus resembling *Thrissops* in general characters, but distinguished from it by its relatively much shorter and compact form of trunk, and by the more anterior position of the dorsal fin, which arises somewhat in advance of the anal and is not much extended. Anal relatively shorter than in *Thrissops*.

50. **Parathrissops furcatus** sp. nov. (Plate LIX, fig. 2.)

Type.—Nearly complete fish in counterpart; Carnegie Museum Cat. No. 4029 + 4029*a*.

The type and only known species, attaining a total length of about 23 cm. Head with opercular apparatus contained four and one-half times in the total length of the fish; maximum depth of trunk equalling the length of the head with opercular apparatus, and contained a little more than two and one-half times in the length of the trunk from the pectoral arch to the base of the caudal fin. Vertebræ about forty-four in number, half of them being abdominal, and half caudal. Pelvic fins arising but little nearer to the anal than to the pectorals; dorsal fin, with fifteen rays, arising somewhat in advance of the origin of the anal, which is much elevated in front, and comprises about twenty-two rays; caudal fin deeply forked and with expanded lobes. Scales thin, ornamented with exceedingly delicate concentric striæ.

The holotype of this species is an admirably preserved individual having a total length of 23 cm. and depth of 5 cm. It is readily distinguished from all other species by the form and proportions of the body and more forward position of the dorsal fin, together with the deeply furcate and broad-lobed character of the caudal.

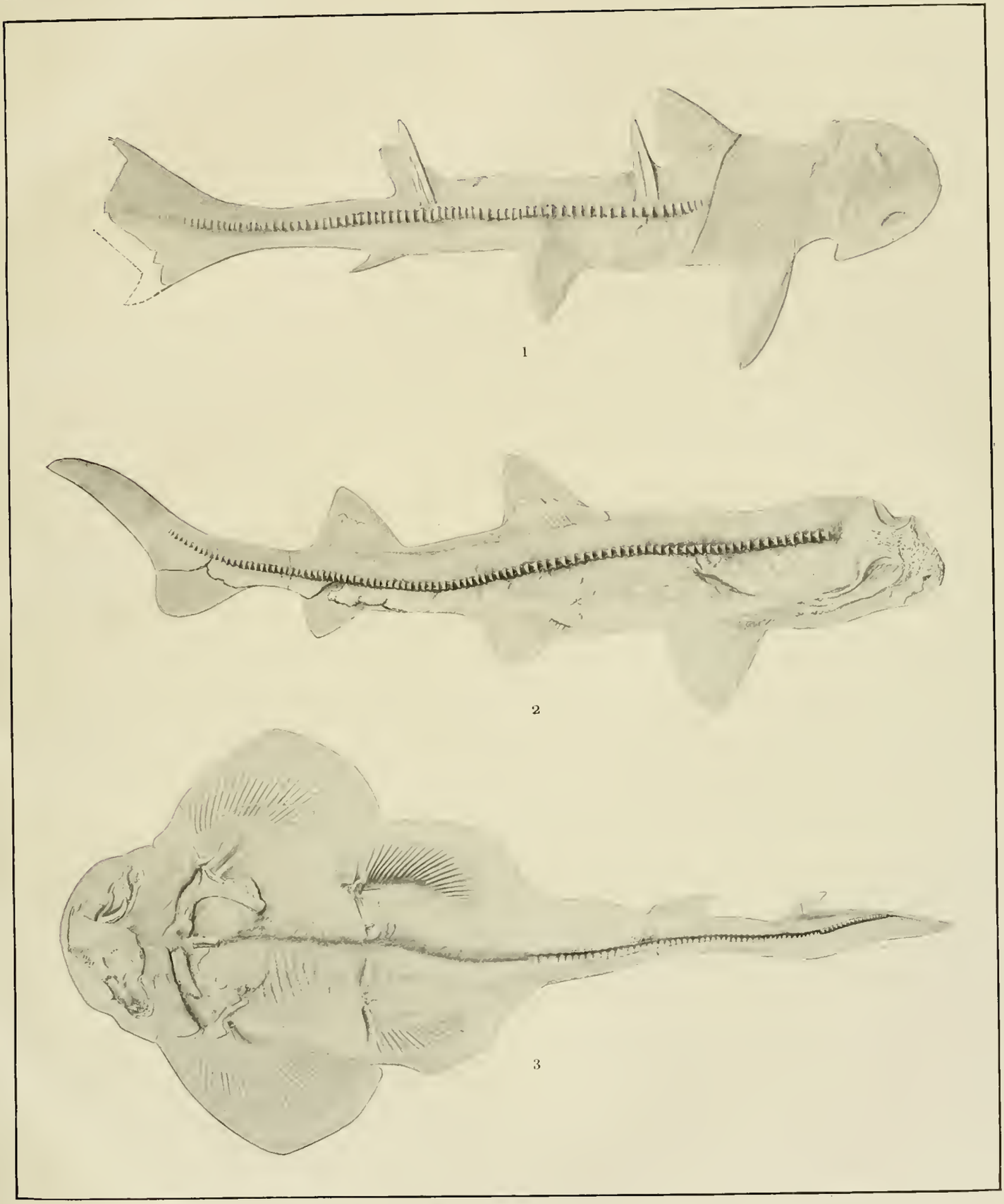

FIG. 1. *Cestracion zitteli* EASTMAN. C. M. CAT. FOSS. FISHES, NO. 4423. (SLIGHTLY ENLARGED.)
FIG. 2. *Phorcynis catulina* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, NO. 4780. × $\frac{26}{100}$.
FIG. 3. *Squatina minor* EASTMAN. C. M. CAT. FOSS. FISHES, NO. 4737. × $\frac{31}{100}$.

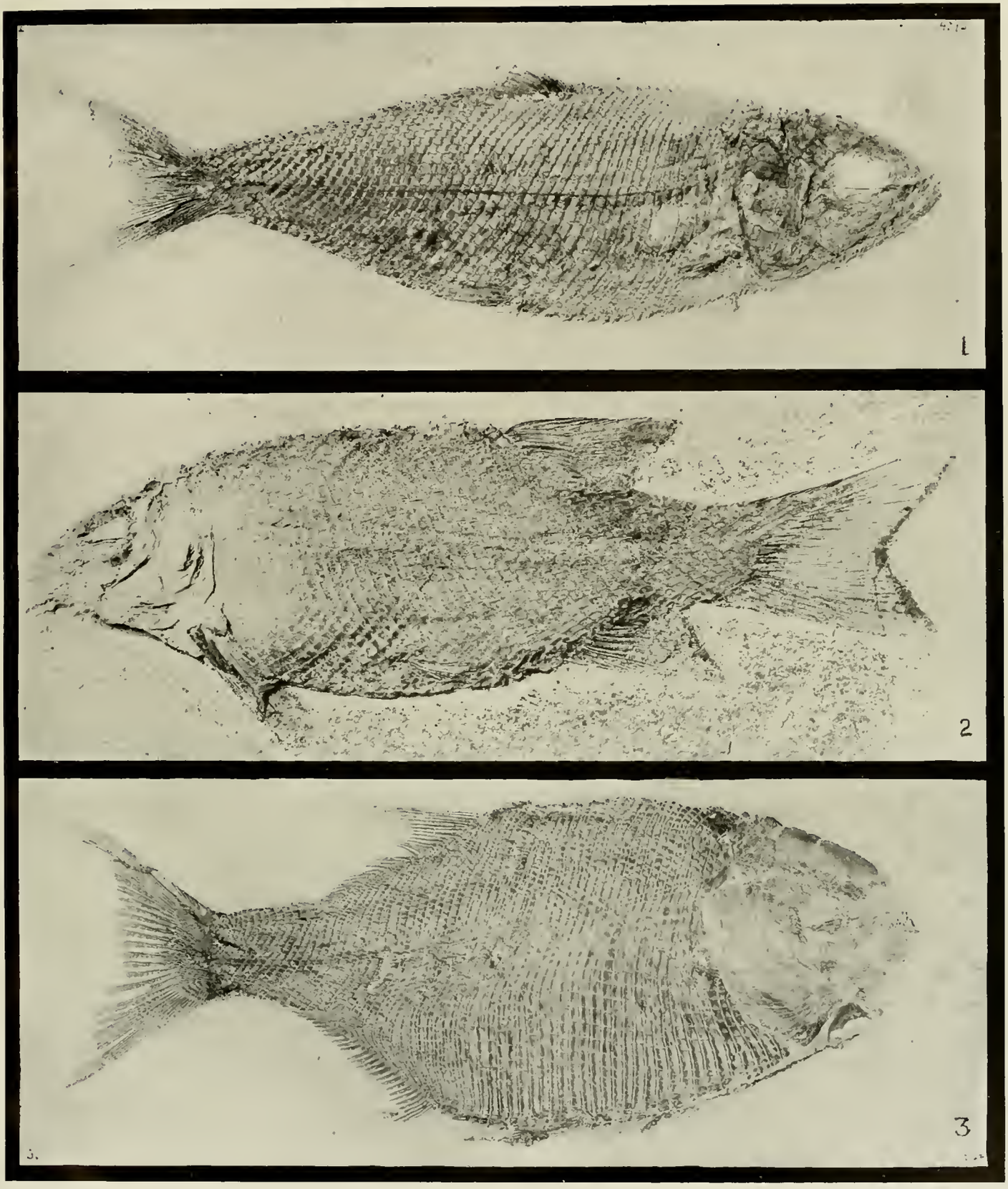

FIG. 1. *Pholidophorus macrocephalus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4793 (227 MM.).
FIG. 2. *Lepidotus ovatus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4730 (372 MM.).
FIG. 3. *Homœolepis suborbiculata* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4762 (410 MM.).

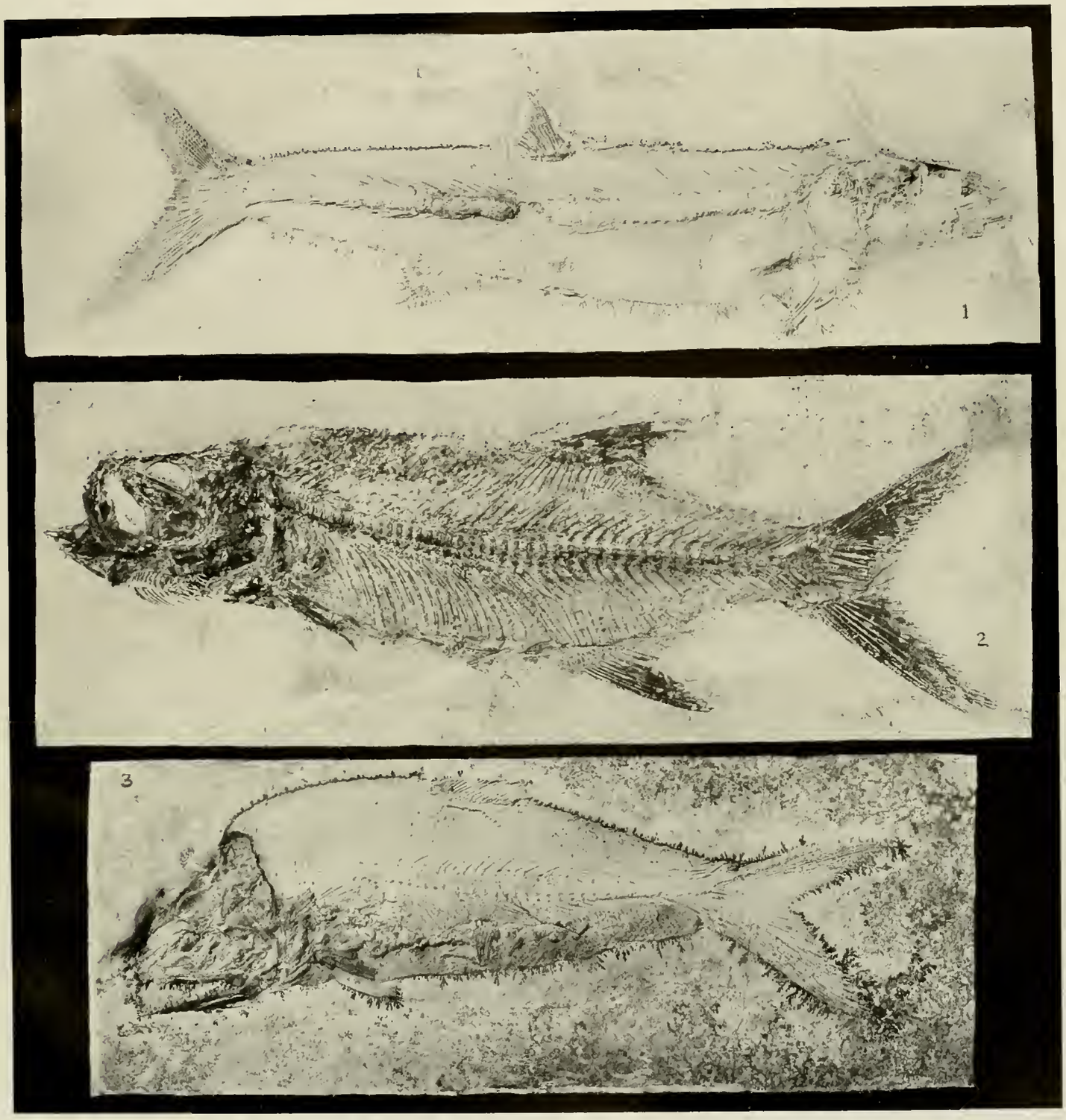

FIG. 1. *Caturus pachyurus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4724 (405 MM.).
FIG. 2. *Parathrissops furcatus* GEN. ET SP. NOV. C. M. CAT. FOSS. FISHES, No. 4029 (235 MM.). TYPE.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 872 (194 MM.).

FIG. 1. *Belonostomus muensteri* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4850 (292 MM.).
FIG. 2. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 871 (200 MM.).
FIG. 3. *Sauropsis depressus* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4766. (300 MM. FROM END OF LOWER LOBE OF TAIL TO END OF PECTORAL FIN ON SLAB.)

FIG. 1. *Mesodon macropterus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4456 (50 MM.).
FIG. 2. *Mesodon macropterus* (AGASSIZ). (COUNTERPART) DO., No. 4456*a* (50 MM.).
FIG. 3. *Gyrodus frontatus* AGASSIZ. JUV. C. M. CAT. FOSS. FISHES, No. 3003 (57 MM.). FIGURE REVERSED ON PLATE.
FIG. 4. *Caturus furcatus* VAR. *macrurus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 866 (155 MM.).
FIG. 5. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4809 (483 MM.).

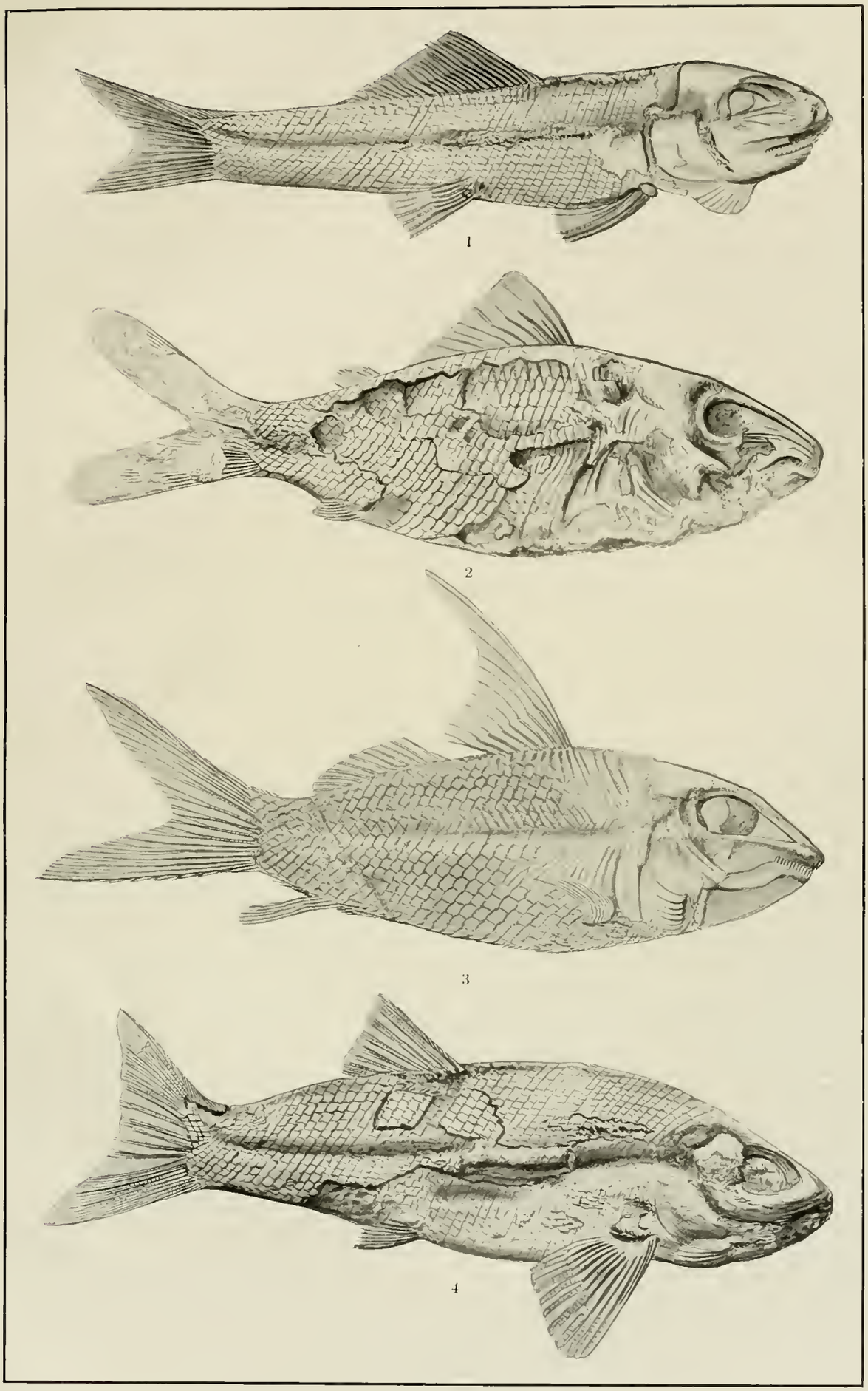

FIG. 1. *Ophiopsis attenuata* WAGNER. C. M. CAT. FOSS. FISHES, No. 4856 (96 MM.).
FIG. 2. *Propterus conidens* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4825 (93 MM.). TYPE.
FIG. 3. *Propterus microstomus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4468 (96 MM.).
FIG. 4. *Histionotus reclinis* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5002 (95 MM.). TYPE.

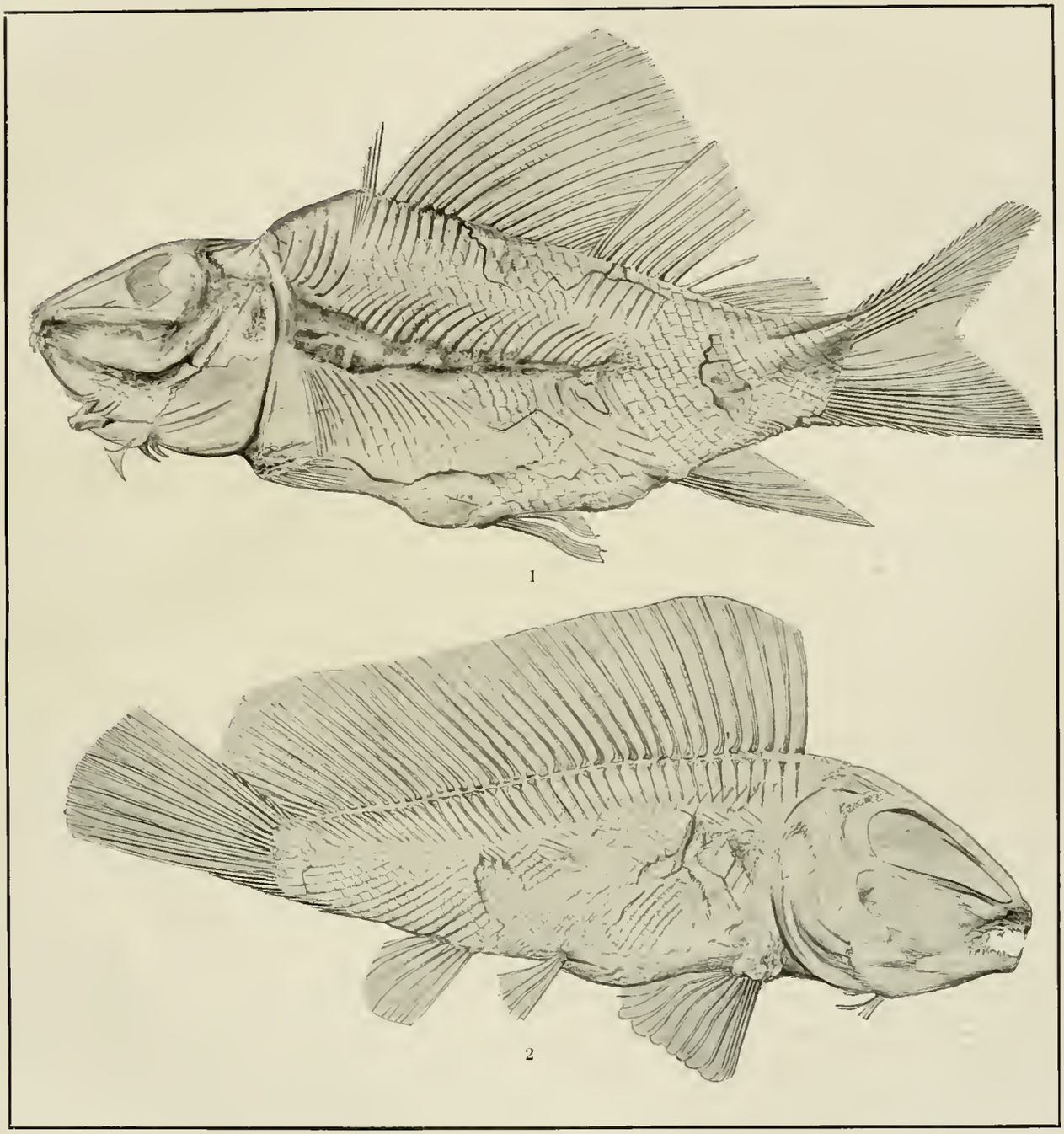

FIG. 1. *Propterus speciosus* WAGNER. C. M. CAT. FOSS. FISHES, No. 4718 (167 MM.).
FIG. 2. *Macroscmius rostratus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4764 (160 MM.).

FIG. 1. *Eugnathus longiserratus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4719 (145 MM.).
FIG. 2. *Eugnathus longiserratus* (AGASSIZ). C. M. CAT. FOSS. FISHES, No. 4686 (180 MM.).
FIG. 3. *Aspidorhynchus acutirostris* (BLAINVILLE). C. M. CAT. FOSS. FISHES, No. 4823 (152 MM.).

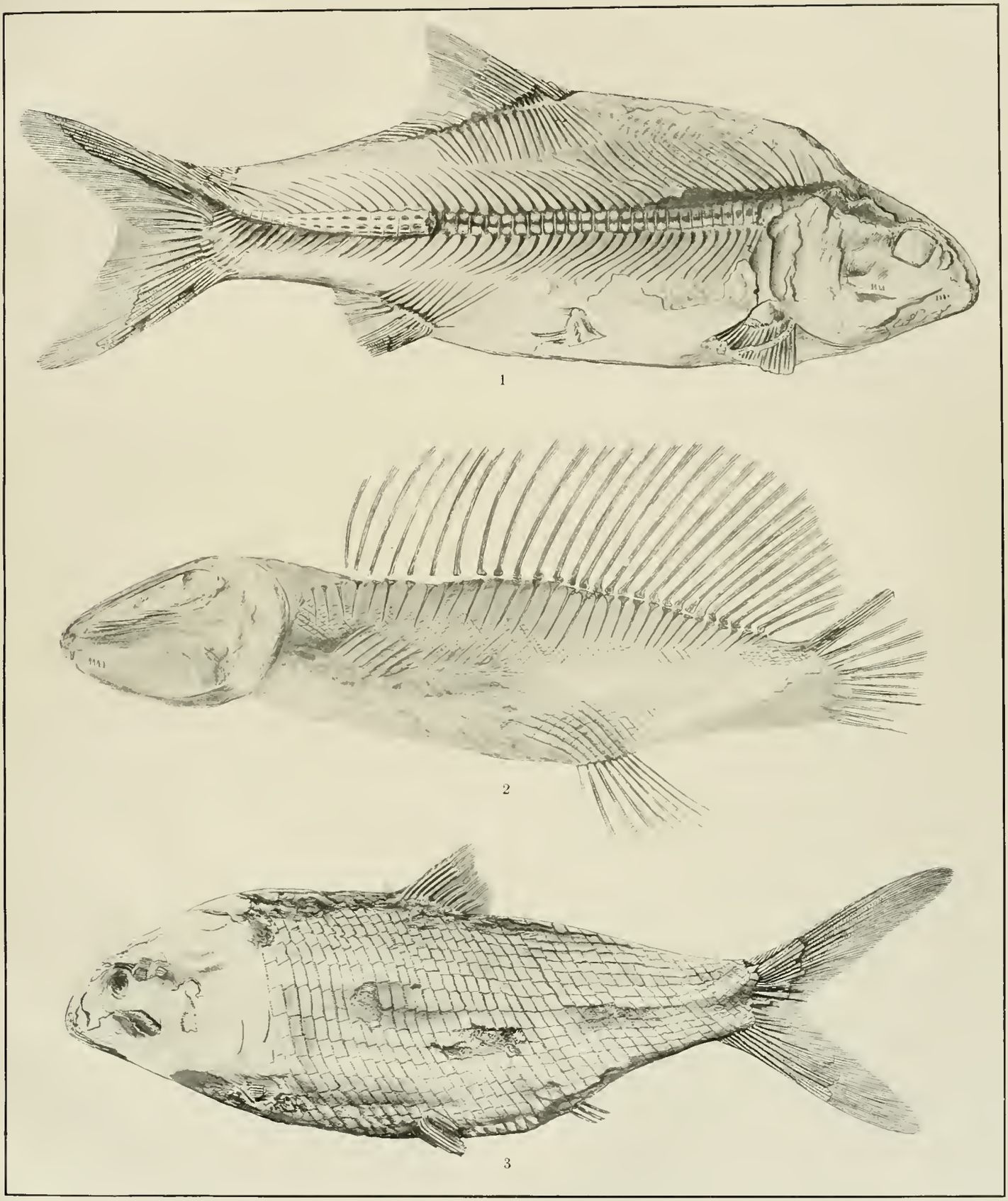

FIG. 1. *Œonoscopus cyprinoides* (WAGNER). C. M. CAT. FOSS. FISHES, No. 4700 (324 MM.).
FIG. 2. *Macrosemius dorsalis* SP. NOV. C. M. CAT. FOSS. FISHES, No. 4765 (195 MM.). TYPE.
FIG. 3. *Pholidophorus macrocephalus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4729 (297 MM.).

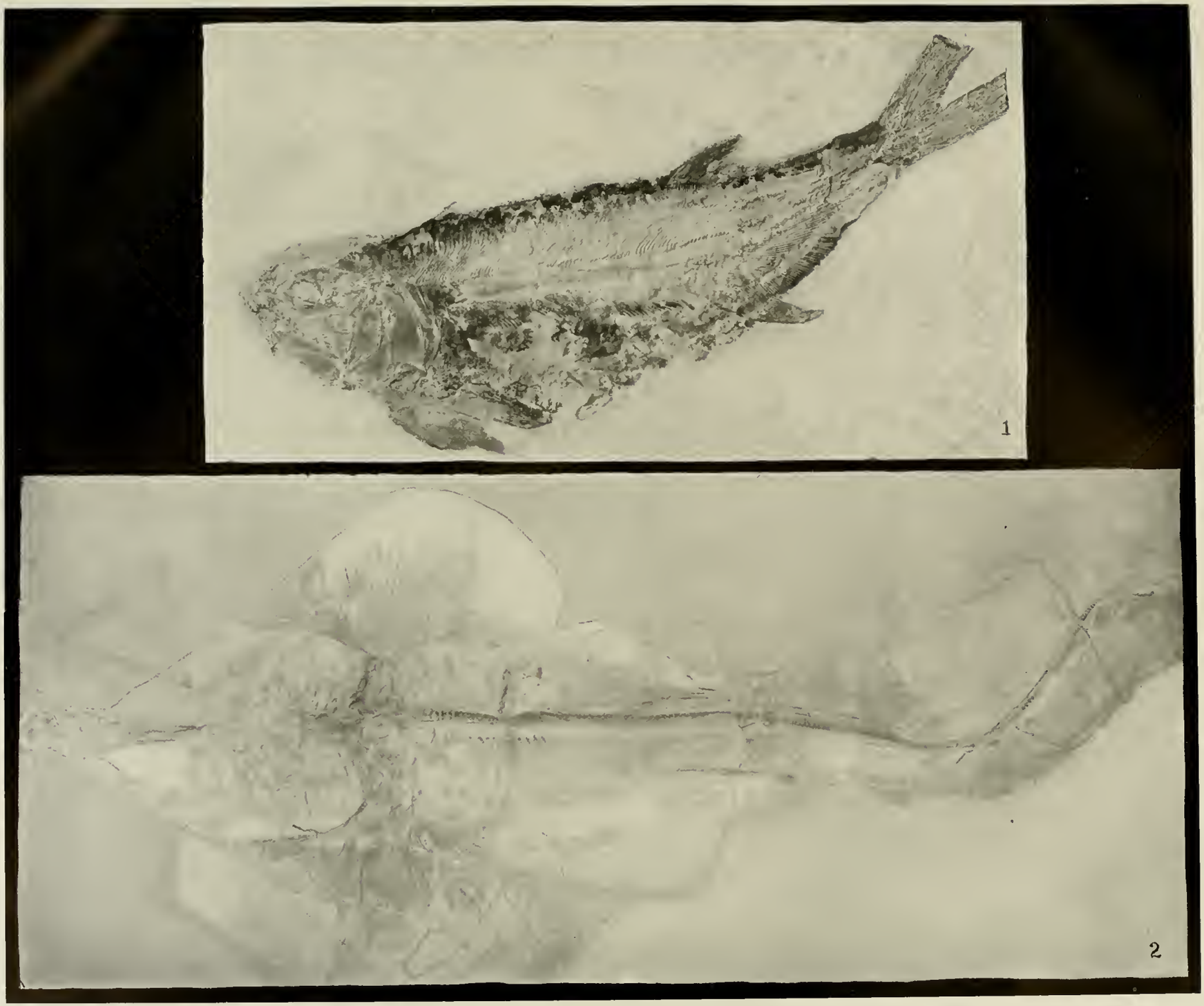

FIG. 1. *Sauropsis curtus* SP. NOV. C. M. CAT. FOSS. FISHES, NO. 4772 (265 MM.). TYPE.
FIG. 2. *Rhinobatus bugesiacus* (THIOLLIÈRE). C. M. CAT. FOSS. FISHES, NO. 5396 (137.5 CM.).

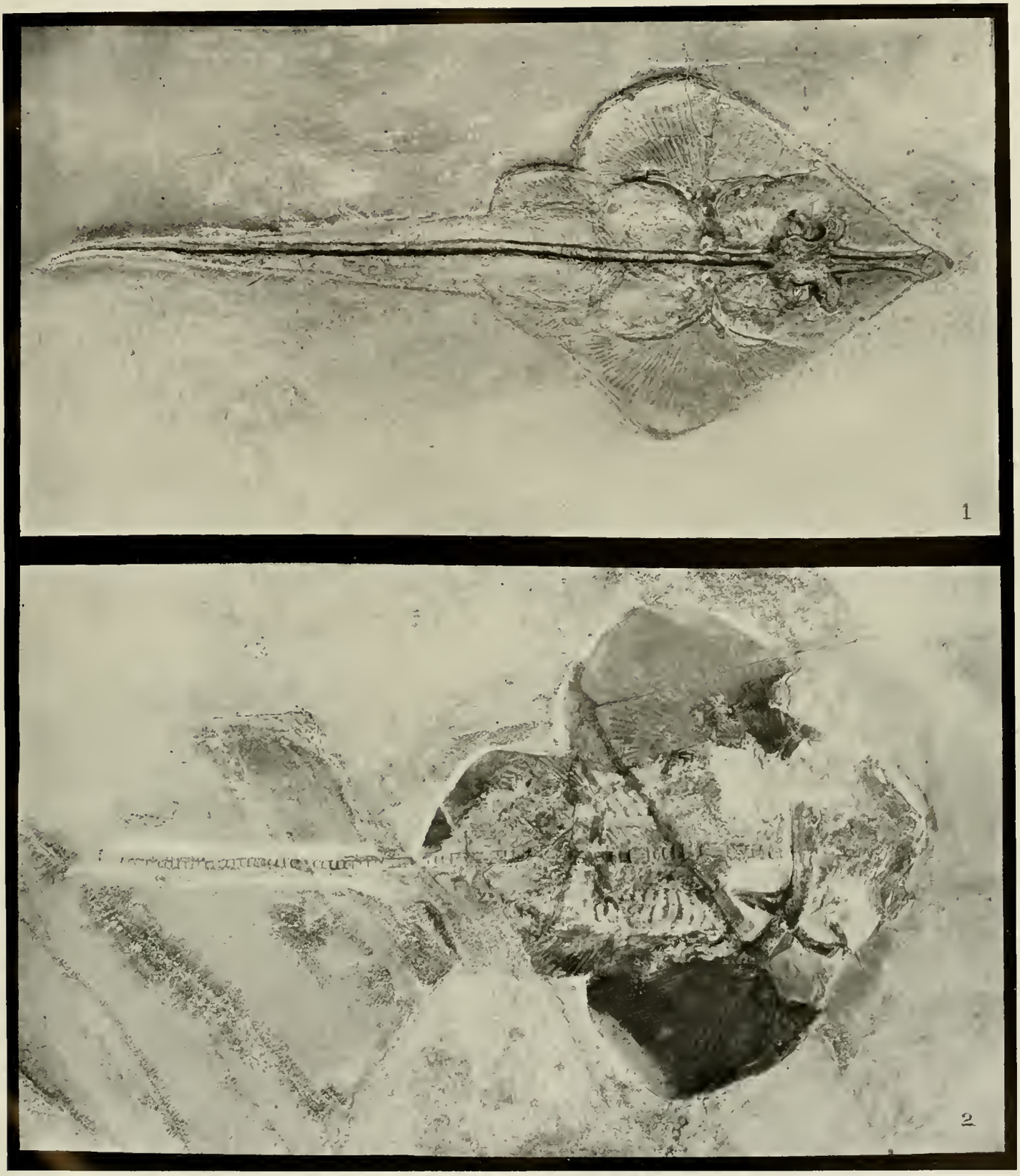

FIG. 1. *Belemnobatis sismondæ* THIOLLIÈRE. C. M. CAT. FOSS. FISHES, NO. 4408. 683 MM.
FIG. 2. *Squatina alifera* MÜNSTER. C. M. CAT. FOSS. FISHES, NO. 5397. 965 MM.

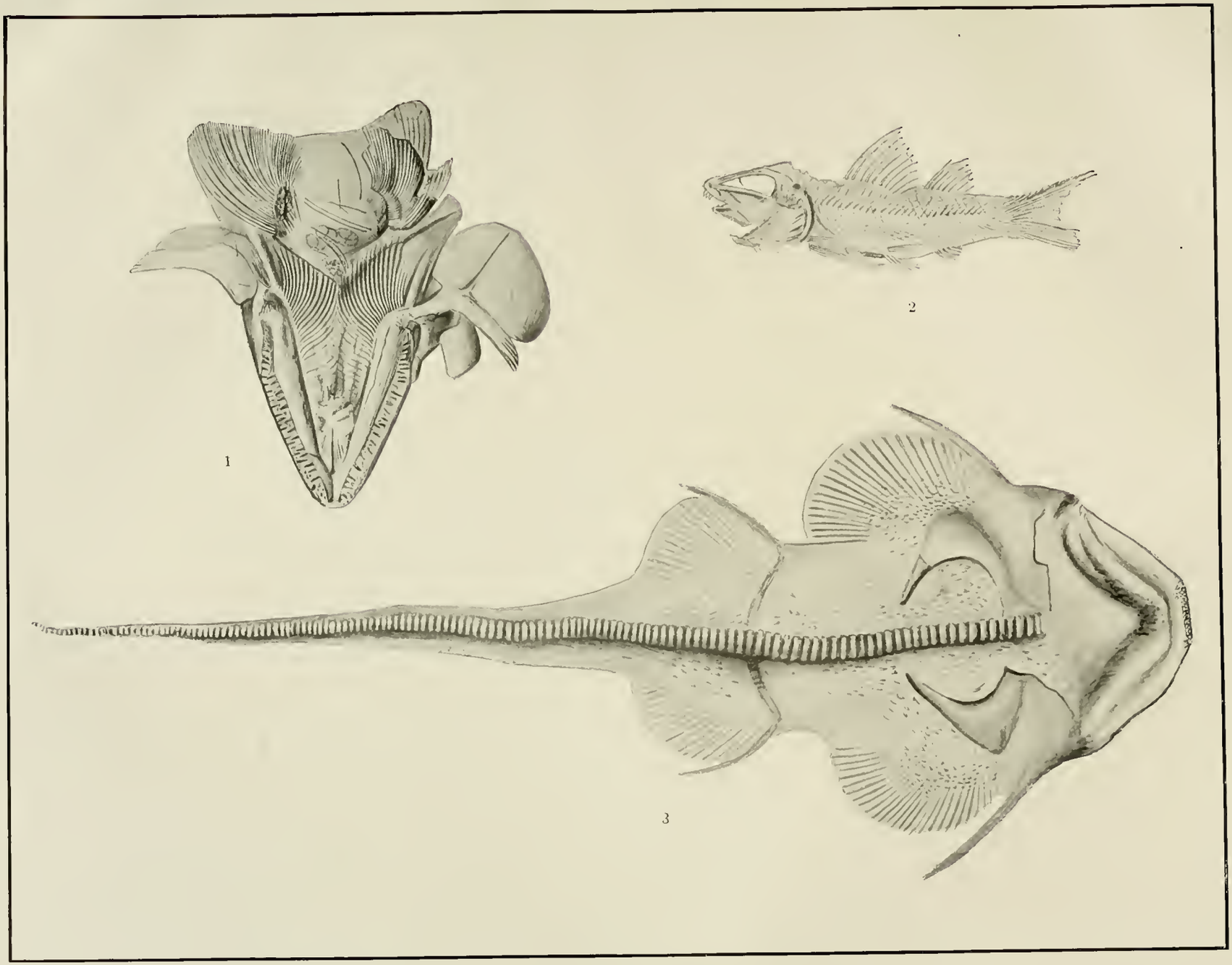

FIG. 1. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4451. × $\frac{1}{1}$.
FIG. 2. *Notagogus decoratus* SP. NOV. C. M. CAT. FOSS. FISHES, No. 5110. × $\frac{3}{2}$. (TYPE.)
FIG. 3. *Squatina speciosa* H. VON MEYER. C. M. CAT. FOSS. FISHES, No. 4054. × $\frac{3}{2}$.

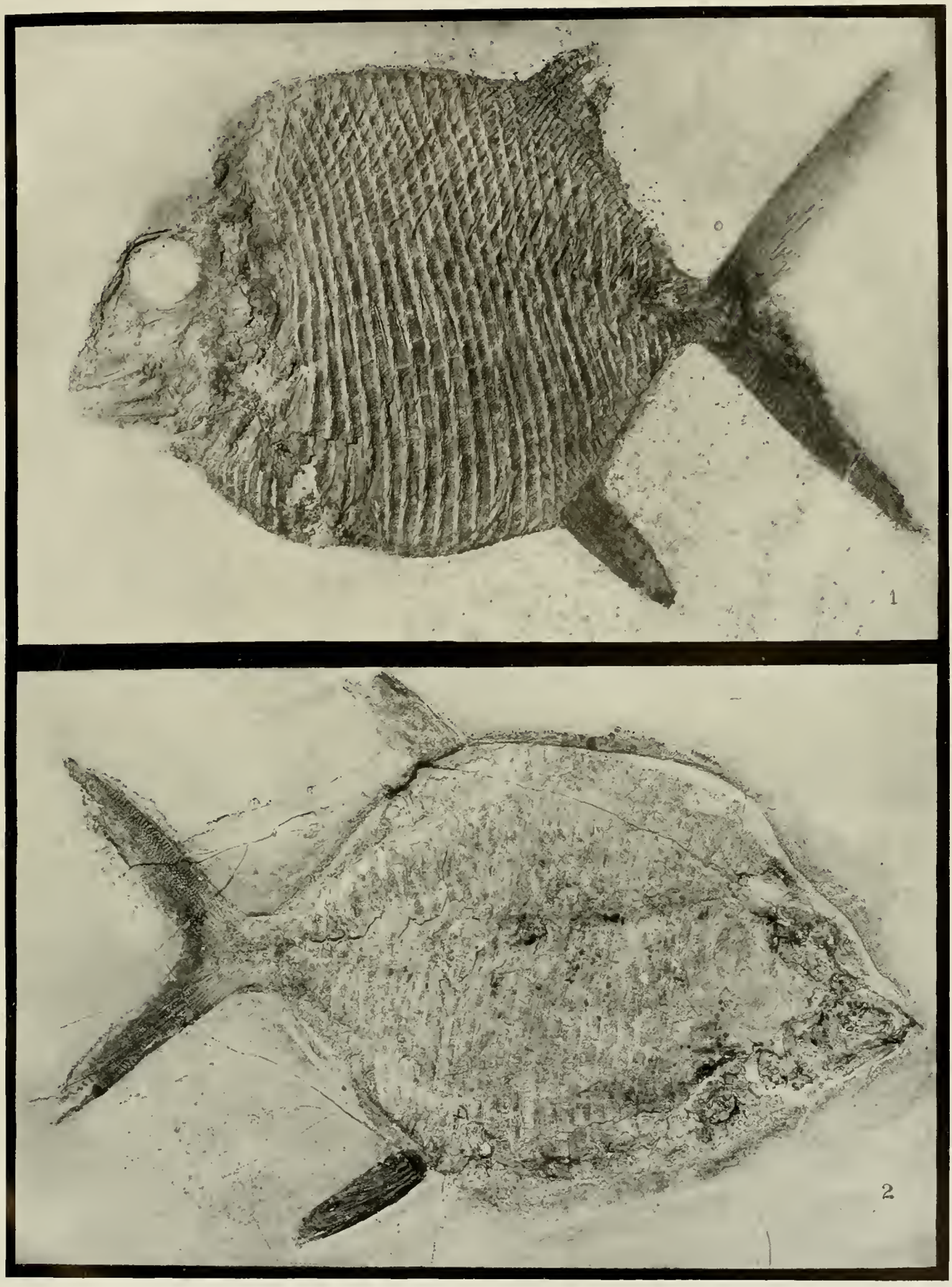

FIG. 1. *Gyrodus macrophthalmus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4734. 252 MM.
FIG. 2. *Gyrodus circularis* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4407. 850 MM.

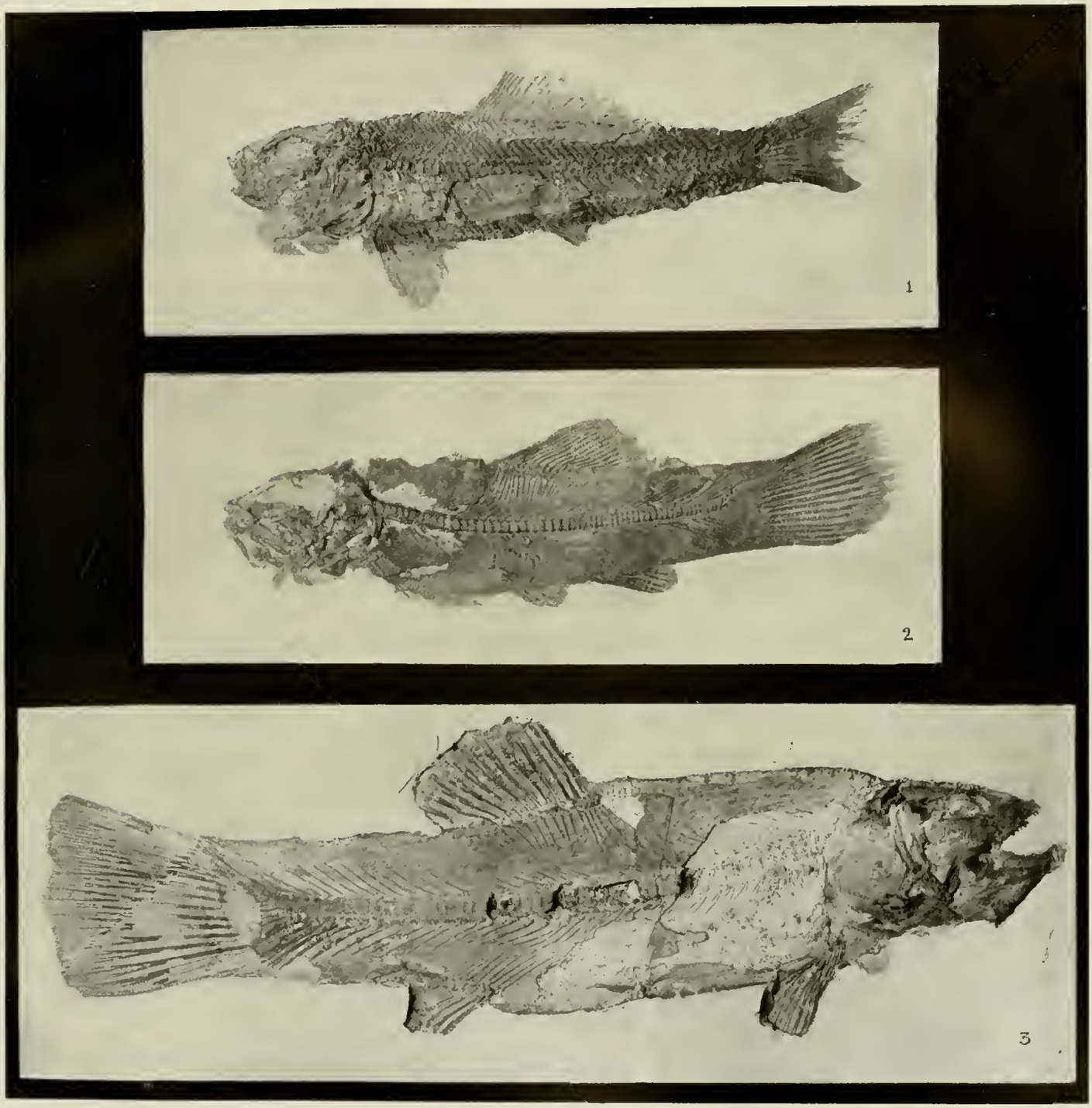

FIG. 1. *Ophiopsis procera* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4690. 140 MM.
FIG. 2. *Megalurus elegantissimus* WAGNER. C. M. CAT. FOSS. FISHES, No. 4854. 142 MM.
FIG. 3. *Megalurus lepidotus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 4732. 365 MM.

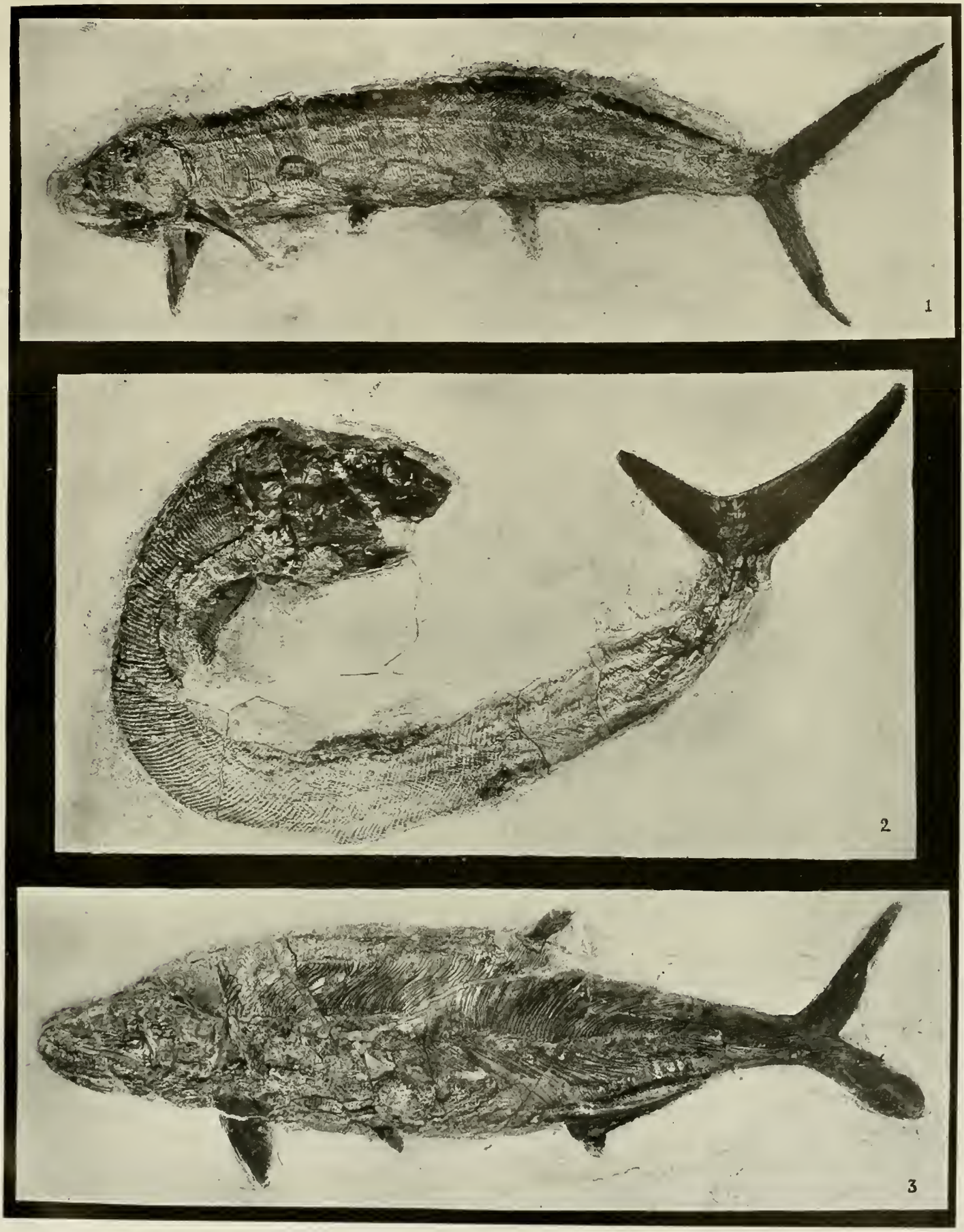

FIG. 1. *Hypsocormus macrodon* (WAGNER). C. M. CAT. FOSS. FISHES, NO. 5399. 705 MM.

FIG. 2. *Hypsocormus macrodon* (WAGNER). C. M. CAT. FOSS. FISHES, NO. 5400. 905 MM. FROM CURVE TO END OF LOWER LOBE OF CAUDAL.

FIG. 3. *Hypsocormus insignis* WAGNER. C. M. CAT. FOSS. FISHES, NO. 5398. 530 MM.

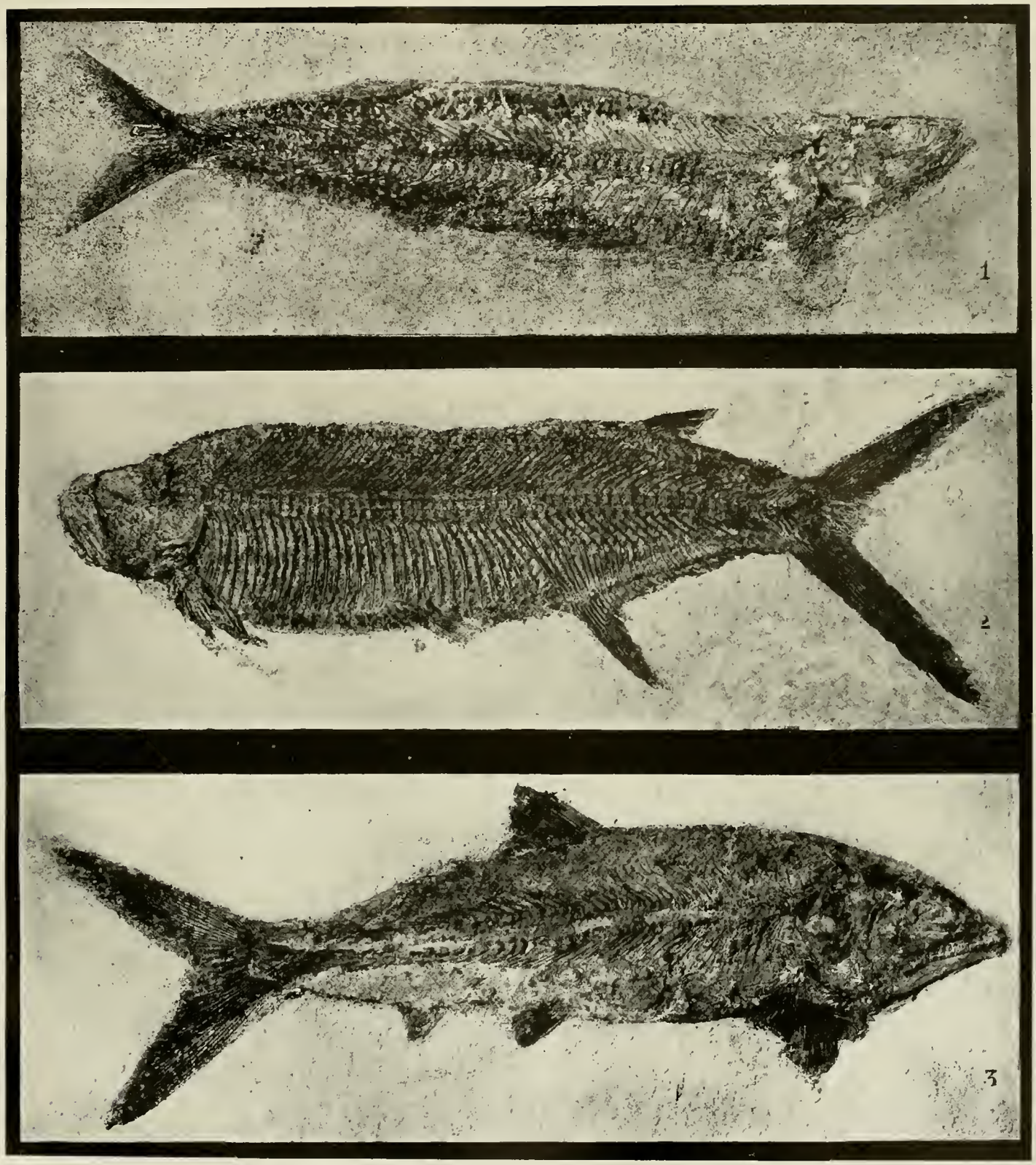

FIG. 1. *Thrissops salmoneus* (BLAINVILLE). C. M. CAT. FOSS. FISHES, NO. 4717. 250 MM.
FIG. 2. *Thrissops formosus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4030. 288 MM.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, NO. 4774. 238 MM.

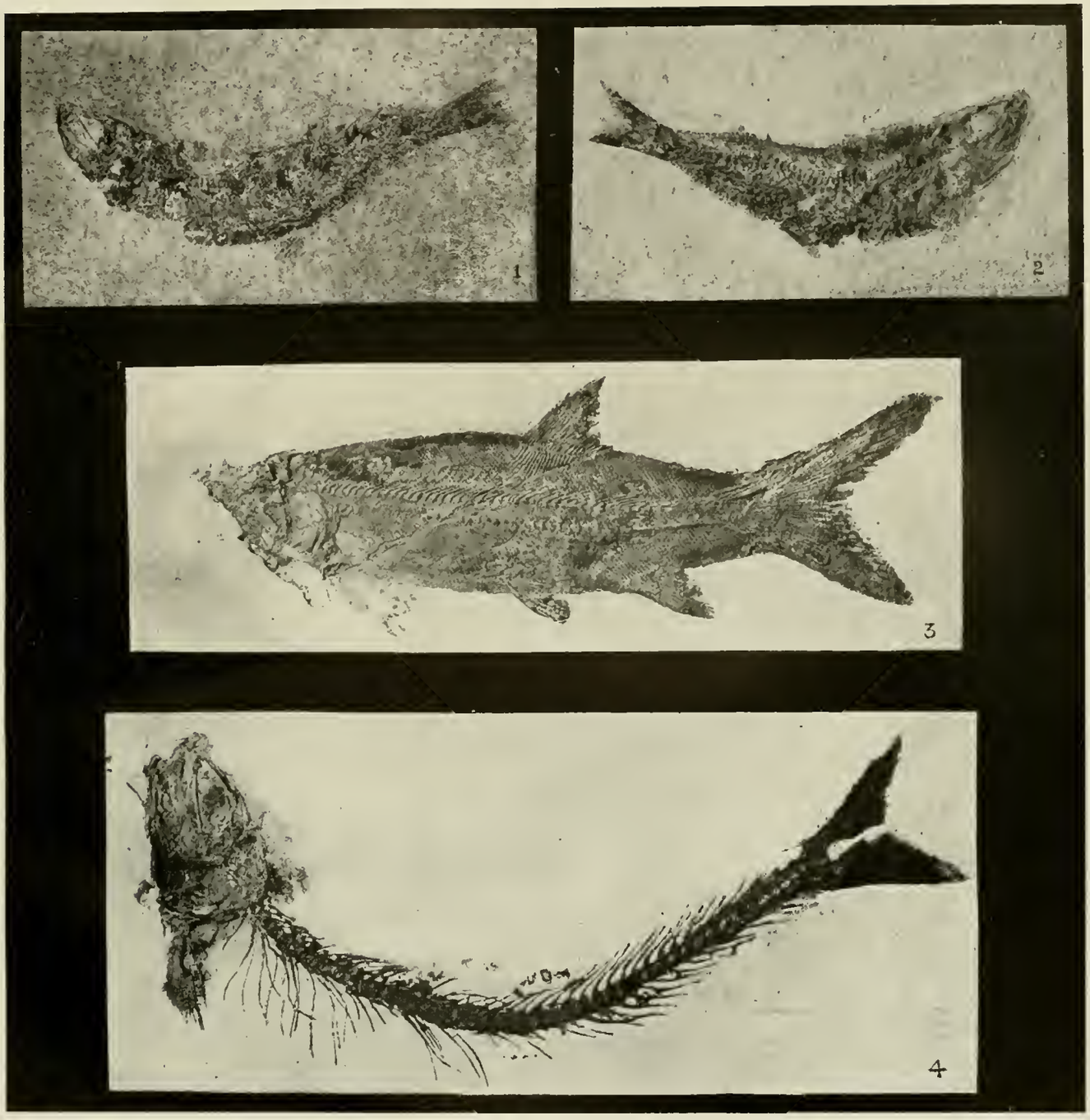

FIG. 1. *Leptolepis sprattiformis* (BLAINVILLE). C. M. CAT. FOSS. FISHES, No. 4108. 95 MM.
FIG. 2. *Leptolepis sprattiformis* (BLAINVILLE). C. M. CAT. FOSS. FISHES, No. 4109. 95 MM.
FIG. 3. *Caturus furcatus* AGASSIZ. C. M. CAT. FOSS. FISHES, No. 5049. 160 MM.
FIG. 4. *Æthalion knorri* (BLAINVILLE). C. M. CAT. FOSS. FISHES, No. 5017. 180 MM. OVER ALL.

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